CRYOGENIC

DRY MAGNETIC SEPARATION OF EASTERN COALS

MILESTONE 3

Operating Parameter Study on Three (3) Canadian Coals

Report by
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1.0 OBJECTIVE OF STAGE 3 TESTS

Stage 2 testing of LINGAN, KIPP and PRINCE coal produced a complete set of reference data. The aim of Stage 3 work is to evaluate and compare the inclined fall separation process with that of the free falling curtain and deflecting ramp employed in Stage 2 work.

2.0 DESCRIPTION OF COALS TESTED

The same starting material was used as for Stage 1 and 2, and as reported in Section 2 of Stage 1 report.

3.0 PROCEDURES

3.1 One test method has been utilised throughout this stage of testwork, that being the inclined fall separation process - see Appendix I for details. In all forty-nine test passes were carried out, tests 200-248, which were all multi-split separations.

3.2 Separation variables

Figure 1 shows the process and outlines the separation variables. At this early stage of development of the inclined fall separator the process variables of particle drop height (A, inclined distances above magnet field centre line) throughput and horizontal distance (B) between hopper discharge and cryostat were to be investigated, whilst keeping other variables such as magnet current and incline angle constant.

Two series of tests were completed - in each a particular coal sample was tested. One series was conducted with A at 100mm, the other with A at 35mm, with the throughputs and variable B being varied for each sample.

The throughputs were higher than those utilised in the previous Stages 1 and 2, being nearer to those expected in an industrial process.

Table 1 summarises the test conditions.

3.3 Multi-split separation details

The use of a cleaning belt in this process meant that no scalping of the coal for removal of strongly magnetics was required as this type of material is carried out of the magnetic field where it falls under gravity.

During the multi-split tests the products collected, which varied in amount due to the spread of the resulting fan of material, were classified with M1 being the magnetic product, M2 being less magnetic, and so on. The last product being the least, or non-magnetic fraction.

4.0 RESULTS

Multi-split weight distributions and selected chemical analysis data, as performed by CANMET, are provided in Tables 2.1-2.52. The separation results are also shown in graphical form, Figures 2-16. In each case the percentage mass removed as the magnetic fraction is plotted against the percentage of ash removal.

5.0 TECHNICAL DISCUSSION

One primary objective of tests performed in this stage was to generally evaluate the separation achieved; another was to compare results obtained with those in Stage 2 work.

The majority of tests gave optimistic separation results. When the results of this Stage 3 testwork were compared to those of the results produced in Stage 2, it was found that only the PRINCE coal samples showed any improvements in the recovery of ash to the magnetic product for a given percentage of mass removed. The other samples, LINGAN and KIPP, gave results that were the same, or worse, than those obtained in Stage 2 work.

In general the lower the throughput of the separator the increased efficiency of separation; this observation was more noticeable with decreasing size and reduced with increasing size of coal.

The effect of varying the drop height (A) on the separation depends upon the particular coal under test and its size range. For KIPP coal in all size ranges the efficiency of separation was slightly improved at the largest size fraction with A at 35mm, and increased greatly with A at 35mm for the smallest size fraction. For LINGAN coal no effect could be detected for varying A at the largest size fraction, with varying resultant effects noted with the reduction in size. PRINCE coal was not tested fully for any conclusions to be made. With the variable B distance between hopper discharge and cleaning belt, all coals, without exception, gave results that were the same, or better, with the coal being presented to the separator at the closer distance.

When comparisons are made between the different sized samples of the same coals the efficiency of separation decreased with decreasing size, but the LINGAN 1 sample (2.8 x 1.4mm) not being fully liberated gave a reduced efficiency when compared to that of LINGAN 2 coal, which gave the highest efficiency of separation for this particular coal.

6.0 CONCLUSION

It can be concluded from Stage 3 work that :-

- at the early stage of development of the inclined fall separator the separation achieved compared favourably, though not as good, with the well developed free falling curtain with deflecting ramp (Stage 2), especially when considering the greater throughput and single pass used in the Stage 3 tests.

- increased throughput on the separator decreases separation efficiency to a greater extent with smaller sized coals.

- efficiency of separation is greatest at the liberation size of the coals, decreasing with decreasing size.

- more testwork is required to optimise the process, for example, the effect of the process variable of magnet inclined angle should be studied in greater depth.

KEY TO NOTATION USED ON INCLINED FALL MULTI SPLIT SEPARATION TESTS.

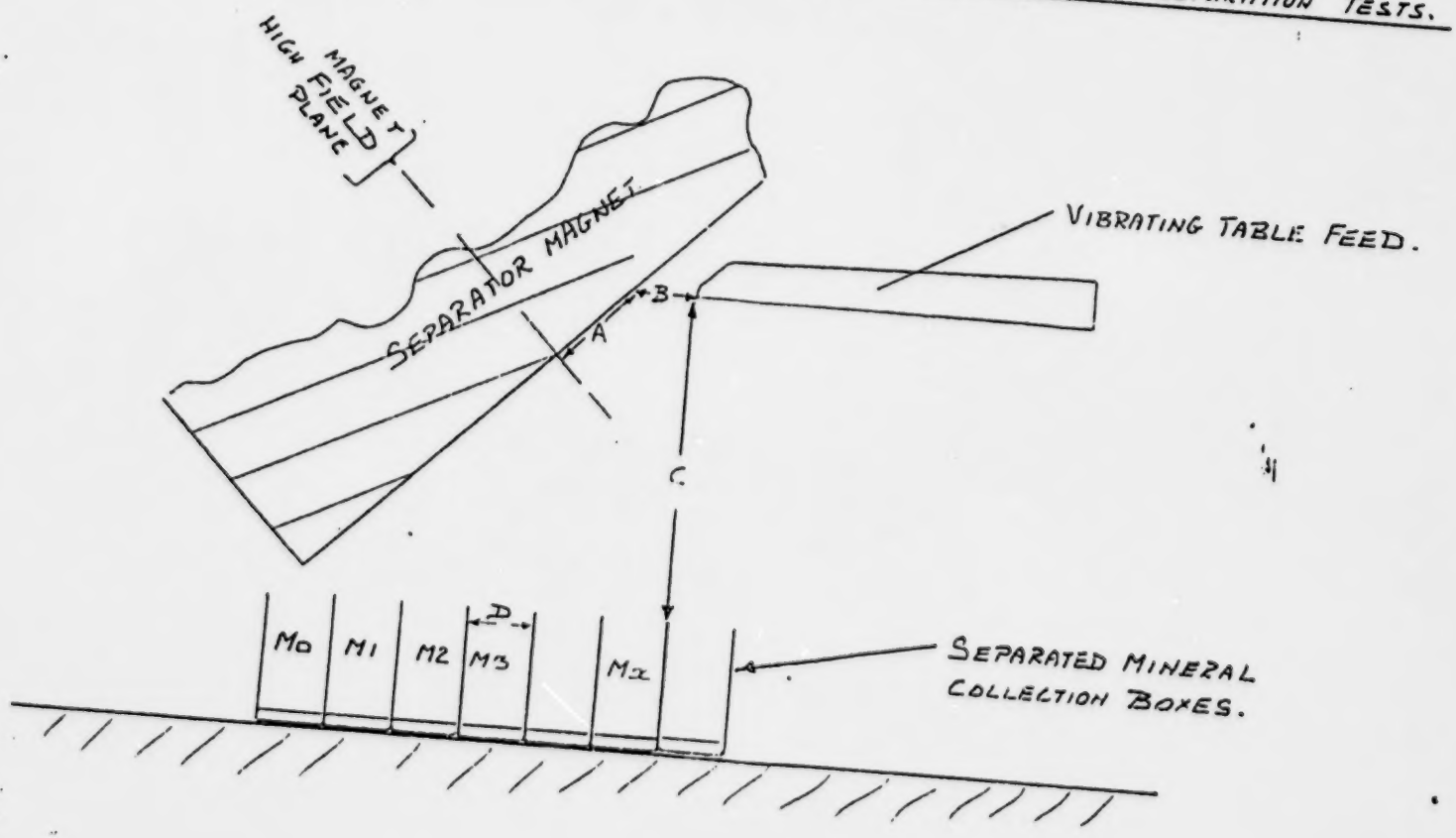

TABLE 1

TEST CONDITIONS

All tests at magnet current 65 Amps, and inclined angle 22°.

Test No.	Sample	A (mm)	B (mm)	Throughput (TPHPM)
200	LINGAN 2	100	16	2.4
201		100	16	3.6
202		100	16	5.5
203	KIPP 6	100	14	2.8
204		100	14	4.1
205		100	17	6.7
105.R		100	17.5	6.2
206	KIPP 5	100	16	2.1
207		100	16	3.6
208		100	16	5.4
209	LINGAN 3	100	16	3.0
210		100	16	4.7
211		100	18	5.6
212	PRINCE 8	100	13	2.5
213		100	15	4.2
214		100	15	6.6
215	LINGAN 1	100	16	2.4
216		100	16	4.3
217		100	20	7.2
218	LINGAN 4	100	13	1.4
219		100	14	1.9
220	KIPP 7	100	14	1.5
221		60	14	1.5
222		35	14	1.5
223		35	15	2.4
224		35	16	3.7
225	LINGAN 4	35	15	1.4
226		35	15	2.0
227		35	16	4.0

Test No.	Sample	A (mm)	B (mm)	Throughput (TPHPM)
228	PRINCE 9	35	15	1.6
229		35	13	2.2
230	PRINCE 8	35	13	1.6
231		35	14	2.6
232		35	15	4.0
233	KIPP 6	35	15	1.7
234		35	15	2.6
235		35	15	3.6
236		35	17	6.6
237	LINGAN 3	35	16	3.0
238		35	17	4.3
239		35	19	6.5
240	LINGAN 2	35	16	2.3
241		35	16	3.6
242		35	17	5.7
243	KIPP 5	35	16	2.2
244		35	16	3.6
245		35	16	5.8
246	LINGAN 1	35	18	3.0
247		35	19	3.6
248		35	20	7.0

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TABLE: 2.1

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

TEST NO: 200

JOB NO : 2044.

SAMPLE : LINGAN #2

TESTING STAGE: 3

SIZE RANGE: 1.4 X 0.6mm

DATE :

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 100
   B: 16
   C: 12.5
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 2.4 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE	DIST.			%DIST	CUM
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH
FEED	253.2	100.0		14.3	100.0	
M0						
M1	23.6	9.4	9.4	81.7	53.7	53.7
M2	8.3	3.3	12.7	66.4	15.3	69.0
M3	10.8	4.3	17.0	37.4	11.2	80.2
M4	208.9	83.0	100.0	3.4	19.8	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	251.6	100.0			100.0	

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.2

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

TEST NO: 201

JOB NO : 2044.

SAMPLE : LINGAN #2

TESTING STAGE: 3

SIZE RANGE: 1.4×0.6mm

DATE :

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 100
B: 16
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 3.6 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	%CUM	%ASH	%DIST ASH	CUM %ASH
FEED	250.8			14.8		
M0						
M1	26.9	10.8	10.8	82.1	60.1	60.1
M2	7.5	3.0	13.8	61.5	12.5	72.6
M3	4.8	1.9	15.7	40.2	5.2	77.8
M4	210.5	84.3	100.0	3.9	22.2	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	250.5	100.0				

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.3

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 202

SAMPLE : LINGAN #2

SIZE RANGE: 1.4x0.6mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 100
B: 16
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 5.5 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE	DIST.			%DIST	CUM
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH
FEED	245.9	100.0		14.2		
M0						
M1	24.4	10.0	10.0	82.5	58.0	58.0
M2	6.7	2.7	12.7	64.3	12.2	70.2
M3	4.9	2.0	14.7	41.1	5.8	76.0
M4	209.0	85.3	100.0	4.0	24.0	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	245.0	100.0				

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TABLE: 2.4

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 203

SAMPLE : KIPP #6

SIZE RANGE: 0.6x0.2mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 100
   B: 14
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 2.8 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	252.7			27.9		
M0						
M1	44.2	17.6	17.6	77.4	48.8	488
M2	9.6	3.8	21.4	55.9	7.6	56.4
M3	16.2	6.4	27.8	41.0	9.4	65.8
M4	181.4	72.2	100.0	13.2	34.2	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	251.4					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.5

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 204

SAMPLE : KIPP #6

SIZE RANGE: 0.6×0.2mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 100
B: 14
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 4.1 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE	DIST.			%DIST	CUM
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH
FEED	257.1			27.6		
M0						
M1	43.0	16.7	16.7	76.7	46.4	46.4
M2	12.0	4.7	21.4	52.9	9.0	55.4
M3	25.2	9.8	31.2	34.6	12.3	67.7
M4	176.6	68.8	100.0	13.0	32.3	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	256.8					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.6

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044

TESTING STAGE: 3

DATE :

TEST NO: 205

SAMPLE : KIPP #6

SIZE RANGE: 0.6x0.2 mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 100
   B: 17
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 6.7 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA						
	SAMPLE	DIST.			%DIST	CUM				
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH				
FEED	251.6									
M0										
M1	28.7	11.4	11.4	77.6	31.9	31.9				
M2	10.3	4.1	15.5	61.0	9.0	40.9				
M3	23.5	9.4	24.9	43.3	14.7	55.6				
M4	188.7	75.1	100.0	16.4	44.4	100.0				
M5										
M6										
M7										
M8										
M9										
M10										
	251.2	100.0								

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.7

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

TEST NO: 205R

JOB NO : 2044.

SAMPLE : KIPP #6

TESTING STAGE: 3

SIZE RANGE: 0.6x0.2mm

DATE :

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 100
   B: 175
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 6.2 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	257.5			28.1		
M10						
M1	25.3	9.8	9.8	79.2	27.6	27.6
M2	8.9	3.5	13.3	65.8	8.2	35.8
M3	20.0	7.8	21.1	49.4	13.7	49.5
M4	202.9	78.9	100.0	18.0	50.5	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	257.1					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.8

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 206

SAMPLE : KIPP #5

SIZE RANGE: 2.0×0.6 mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 100
B: 16
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: 2.1 SEC:
6) FEED RATE: TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	258.2					
M10						
M1	44.8	17.6	17.6	74.3	49.5	49.5
M2	9.7	3.8	21.4	52.3	7.5	57.0
M3	15.8	6.2	27.6	37.0	8.7	65.7
M4	184.2	72.4	100.0	12.5	34.3	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	254.5					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.9

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

TEST NO: 207

JOB NO : 2044.

SAMPLE : KIPP #5

TESTING STAGE: 3

SIZE RANGE: 2.0x0.6mm

DATE :

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22
3) DIMENSIONS (mm) A: 100
B: 16
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 3.6 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	248.3					
M0						
M1	44.7	18.1	18.1	77.7	52.0	52.0
M2	10.4	4.2	47.9	47.9	7.4	59.4
M3	18.6	7.5	29.8	32.1	8.9	68.3
M4	172.9	70.2	100.0	12.2	31.7	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	2466					

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TABLE: 2.10

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 208

SAMPLE : KIPP #5

SIZE RANGE: 2.0x0.6mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 100
B: 16
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 5.4 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	252.5			26.1		
M0						
M1	46.3	18.5	18.5	72.4	51.4	51.4
M2	12.9	5.2	23.7	41.9	84	59.8
M3	27.2	10.9	34.6	25.5	107	70.5
M4	163.8	65.4	1000	11.8	29.5	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	250.2					

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TABLE: 2.11

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 209

SAMPLE : LINGAN #3

SIZE RANGE: 0.6x0.2mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 100
B: 16
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 3.0 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	248.1			27.4		
M0						
M1	52.6	21.5	21.5	87.8	69.0	69.0
M2	12.8	5.2	26.7	72.7	13.8	82.8
M3	8.6	3.5	30.2	42.8	5.5	88.3
M4	170.8	69.8	100.0	4.6	11.7	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	244.8	100.0				

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TABLE: 2.12

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

TEST NO: 210

JOB NO : 2044.

SAMPLE : LINGAN #3

TESTING STAGE: 3

SIZE RANGE: 0.6x0.2 mm

DATE :

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 100
   B: 16
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 47 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE	DIST.			%DIST	CUM
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH
FEED	255.7			27.7		
M10						
M1	49.7	19.4	19.4	86.7	60.6	60.6
M2	15.7	6.1	25.5	70.8	15.6	76.2
M3	12.1	4.7	30.2	42.4	7.2	83.4
M4	179.1	69.8	100.0	6.6	16.6	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	256.6					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.13

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 211

SAMPLE : LINGAN #3

SIZE RANGE: 0.6x0.2 mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 100
   B: 18
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 5.6 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE	DIST.			%DIST	CUM
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH
FEED	250.2			27.0		
M10						
M11	49.9	20.0	20.0	83.1	61.6	61.6
M12	11.8	4.7	24.7	57.6	10.0	71.6
M13	21.1	8.5	33.2	35.2	11.1	82.7
M14	166.4	66.8	100.0	7.0	17.3	100.0
M15						
M16						
M17						
M18						
M19						
M10						
	249.2					

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TABLE: 2.14

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 212

SAMPLE : PRINCE #8

SIZE RANGE: 0.6x0.2 mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 100
   B: 13
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 2.5 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA						
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH				
FEED	252.2									
M0										
M1	22.1	8.8	8.8	63.9	27.3	27.3				
M2	9.5	3.8	12.6	58.6	10.8	38.1				
M3	18.5	7.4	20.0	48.2	17.3	55.4				
M4	200.8	800	100.0	11.5	44.6	100.0				
M5										
M6										
M7										
M8										
M9										
M10										
	250.9									

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.15

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

TEST NO: 213

JOB NO : 2044.

SAMPLE : PRINCE #8

TESTING STAGE: 3

SIZE RANGE: 0.6 x 0.2 mm

DATE :

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 100
   B: 15
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 4.2 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA						
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH				
FEED	255.3			20.7						
M10										
M1	20.5	8.0	8.0	64.0	24.8	24.8				
M2	11.2	4.4	12.4	56.2	12.0	36.8				
M3	31.5	12.3	24.7	39.4	23.5	60.3				
M4	192.8	75.3	100.0	10.9	39.7	100.0				
M5										
M6										
M7										
M8										
M9										
M10										
	256.0									

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.16

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

TEST NO: 214

JOB NO : 2044.

SAMPLE : PRINCE #8

TESTING STAGE: 3

SIZE RANGE: 06x0.2mm

DATE :

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 100
   B: 15
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 6.6 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE	DIST.			%DIST	CUM
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH
FEED	255.5					
M0						
M1	18.9	7.5	7.5	61.6	21.6	21.6
M2	14.6	5.8	13.3	50.7	13.7	35.3
M3	73.7	29.2	42.5	25.6	34.9	70.2
M4	145.0	57.5	100.0	11.1	29.8	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	252.2					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.17

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 215

SAMPLE : LINGAN #1

SIZE RANGE: 2.8×1.4 mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 100
   B: 16
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 2.4 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	256.0			30.9		
M0						
M1	57.5	22.7	22.7	86.7	63.6	63.6
M2	18.1	7.2	29.9	73.3	17.1	80.7
M3	14.6	5.8	35.7	40.7	7.6	88.3
M4	162.7	64.3	100.0	5.6	11.7	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	252.9					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.18

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 216

SAMPLE : LINGAN #1

SIZE RANGE: 2.8×1.4 mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 100
B: 16
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 4.3 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	251.2					
M10						
M1	62.1	24.8	24.8	86.7	71.0	71.0
M2	13.1	5.2	30.0	67.9	11.7	82.7
M3	14.7	5.9	35.9	34.5	6.7	89.4
M4	160.2	64.1	100.0	5.0	10.6	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	250.1					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.19

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 217

SAMPLE : LINGAN #1

SIZE RANGE: 2.8x14mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 100
B: 20
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 7.2 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	252.5					
M0						
M1	60.3	23.9	23.9	86.3	68.1	68.1
M2	140	5.6	29.5	65.8	12.1	80.2
M3	19.4	7.7	37.2	32.9	8.4	88.6
M4	158.3	62.8	100.0	5.5	11.4	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	252.0					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.20

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

TEST NO: 218

JOB NO : 2044.

SAMPLE : LINGAN #4

TESTING STAGE: 3

SIZE RANGE: 0.2x0.1mm

DATE :

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 100
B: 13
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 1.4 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	246.4					
M0						
M1	22.0	9.0	9.0	78.2	37.9	37.9
M2	4.5	1.8	10.8	55.6	5.4	43.3
M3	13.2	5.4	16.2	31.7	9.2	52.5
M4	204.7	83.8	100.0	10.5	47.5	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	244.4					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.21

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 219

SAMPLE : LINGAN #4

SIZE RANGE: 0.2x0.1mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 100
   B: 14
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 1.9 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE	DIST.			%DIST	CUM
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH
FEED	254.9					
M0						
M1	18.2	7.2	7.2	78.7	32.5	32.5
M2	3.9	1.5	8.7	66.8	5.7	38.2
M3	7.3	2.9	11.6	45.9	7.6	458
M4	223.5	88.4	100.0	10.7	542	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	252.9					

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MAGNETIC SEPARATION TEST. FACILITY

TABLE: 2.22

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 220

SAMPLE : KIPP #7

SIZE RANGE: 0.2x0.1mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 100
B: 14
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 1.5 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	251.3					
M0						
M1	27.1	10.8	10.8	73.8	28.3	28.3
M2	16.4	6.5	17.3	39.5	9.1	37.4
M3	207.2	82.7	100.0	21.3	62.6	100.0
M4						
M5						
M6						
M7						
M8						
M9						
M10						
	250.7					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.23

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

TEST NO: 221

JOB NO : 2044.

SAMPLE : KIPP #7

TESTING STAGE: 3

SIZE RANGE: 0.2 x 0.1 mm

DATE :

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 60
   B: 14
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 1.5 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE	DIST.			%DIST	CUM
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH
FEED	256.4			27.9		
M0						
M1	29.2	11.5	11.5	72.0	29.7	29.7
M2	34.7	13.6	25.1	40.1	19.6	48.3
M3	190.5	74.9	100.0	18.9	50.7	100.0
M4						
M5						
M6						
M7						
M8						
M9						
M10						
	254.4					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.24

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 222

SAMPLE : KIPP #7

SIZE RANGE: 0.2×0.1 mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
B: 14
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 1.5 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA						
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH				
FEED	249.2									
M0										
M1	27.0	10.9	10.9	75.6	29.1	29.1				
M2	67.6	27.4	38.3	36.0	34.9	64.0				
M3	152.4	61.7	100.0	16.5	36.0	100.0				
M4										
M5										
M6										
M7										
M8										
M9										
M10										
	247.0									

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.25

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 223

SAMPLE : KIPP #7

SIZE RANGE: 0.2×0.1 mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
   B: 15
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 2.4 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	259.5					
M0						
M1	19.5	7.5	7.5	77.5	20.9	20.9
M2	62.2	24.0	31.5	40.3	34.8	55.7
M3	177.2	68.5	100.0	18.0	44.3	100.0
M4						
M5						
M6						
M7						
M8						
M9						
M10						
	258.9					

CRYOGENIC

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.26

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

TEST NO: 224

JOB NO : 2044.

SAMPLE : KIPP #7

TESTING STAGE: 3

SIZE RANGE: 0.2×0.1mm

DATE :

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
   B: 16
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 3.7 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	250.2					
M0						
M1	17.2	6.9	6.9	71.1	17.3	17.3
M2	53.2	21.3	28.2	32.6	24.5	41.8
M3	179.3	71.8	100.0	22.9	58.2	100.0
M4						
M5						
M6						
M7						
M8						
M9						
M10						
	249.7					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.27

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 225

SAMPLE : LINGAN #4

SIZE RANGE: 0.2X0.1mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
   B: 15
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 1.4 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	246.0					
M0						
M1	23.1	9.5	9.5	73.6	39.1	39.1
M2	18.5	7.6	17.1	37.6	16.0	55.1
M3	202.1	82.9	100.0	9.7	44.9	100.0
M4						
M5						
M6						
M7						
M8						
M9						
M10						
	243.7					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.28

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 226

SAMPLE : LINGAN #4

SIZE RANGE: 0.2X0.1mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
B: 15
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 2.0 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE	DIST.			%DIST	CUM
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH
FEED	255.5			17.4		
M0						
M1	24.3	9.6	9.6	73.7	40.7	40.7
M2	24.9	9.8	19.4	31.1	17.5	58.2
M3	204.5	80.6	100.0	9.0	41.8	100.0
M4						
M5						
M6						
M7						
M8						
M9						
M10						
	253.7					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2-29

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

TEST NO: 227

JOB NO : 2044.

SAMPLE : LINGAN #4

TESTING STAGE: 3

SIZE RANGE: 0.2X0.1mm

DATE :

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
   B: 16
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 4.0 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE	DIST.			%DIST	CUM
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH
FEED	245.5			18.1		
M0						
M1	17.2	7.1	7.1	72.1	28.2	28.2
M2	28.4	11.7	18.8	25.3	16.3	44.5
M3	198.2	81.2	100.0	12.4	55.5	100.0
M4						
M5						
M6						
M7						
M8						
M9						
M10						
	243.8					

CRYOGENIC

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.30

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 228

SAMPLE : PRINCE #9

SIZE RANGE: 0.2x0.1 mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
   B: 15
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 1.6 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE	DIST.			%DIST	CUM
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH
FEED	248.4					
M0						
M1	11.2	4.5	4.5	60.5	16.8	16.8
M2	26.7	10.8	15.3	28.4	18.9	35.7
M3	209.2	84.7	100.0	12.3	64.3	100.0
M4						
M5						
M6						
M7						
M8						
M9						
M10						
	247.1					

CRYOGENIC

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.31

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 229

SAMPLE : PRINCE #9

SIZE RANGE: 0.2x0.1mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
   B: 13
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 2.2 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE	DIST.			%DIST	CUM
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH
FEED	260.7					
M0						
M1	8.9	3.4	3.4	60.5	12.8	12.8
M2	29.5	11.4	14.8	29.9	21.2	34.0
M3	221.5	85.2	100.0	12.5	66.0	100.0
M4						
M5						
M6						
M7						
M8						
M9						
M10						
	259.9					

CRYOGENIC

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.32

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 230

SAMPLE : PRINCE #8

SIZE RANGE: 0.6x0.2mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
B: 13
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 1.6 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	253.8					
M0						
M1	35.5	14.1	14.1	61.0	40.4	40.4
M2	22.0	8.7	22.9	48.5	19.8	60.2
M3	195.0	77.2	100.0	11.0	39.8	100.0
M4						
M5						
M6						
M7						
M8						
M9						
M10						
	252.5					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.33

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

TEST NO: 231

JOB NO : 2044.

SAMPLE : PRINCE #8

TESTING STAGE: 3

SIZE RANGE: 0.6x0.2mm

DATE :

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
   B: 14
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 2.6 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA						
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH				
FEED	252.9			20.1						
M0										
M1	32.5	12.9	12.9	61.5	37.8	37.8				
M2	24.7	9.8	22.7	46.3	21.6	59.4				
M3	194.0	77.3	100.0	11.0	40.6	100.0				
M4										
M5										
M6										
M7										
M8										
M9										
M10										
	251.2									

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.34

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 232

SAMPLE : PRINCE #8

SIZE RANGE: 0.6x0.2 mm

TEST CONDITIONS

1) MAGNET CCT: 100 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
   B: 15
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 4.0 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA						
	SAMPLE	DIST.			%DIST	CUM				
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH				
FEED	255.7									
M0										
M1	34.2	13.4	13.4	61.3	38.6	38.6				
M2	36.6	14.4	27.8	37.3	25.2	63.8				
M3	184.0	72.2	100.0	10.7	36.2	100.0				
M4										
M5										
M6										
M7										
M8										
M9										
M10										

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.35

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 233

SAMPLE : KIPP #6

SIZE RANGE:

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
B: 15
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 1.7 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE	DIST.			%DIST	CUM
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH
FEED	250.7					
M0						
M1	38.8	15.5	15.5	76.8	40.1	40.1
M2	27.6	11.0	26.5	55.7	20.6	60.7
M3	36.5	14.6	41.1	26.2	17.9	78.6
M4	148.0	58.9	100.0	10.8	21.4	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	250.9					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.36

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 234

SAMPLE : KIPP #6

SIZE RANGE: 0.6x0.2 mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
B: 15
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 2.6 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE	DIST.			%DIST	CUM
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH
FEED	258.8			28.1		
M0						
M1	35.3	13.6	13.6	78.2	37.9	37.9
M2	31.8	12.3	25.9	57.3	25.1	63.0
M3	191.8	74.1	100.0	14.0	37.0	100.0
M4						
M5						
M6						
M7						
M8						
M9						
M10						
	258.9					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.37

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 235

SAMPLE : KIPP #6

SIZE RANGE: 0.6 x 0.2mm

TEST CONDITIONS

1) MAGNET CCT: 100 AMPS:
2) INCLINE ANGLE: 65°
3) DIMENSIONS (mm) A: 35
   B: 15
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 3.6 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	253.2			28.0		
M0						
M1	39.2	15.5	15.5	76.5	42.3	42.3
M2	36.0	14.2	29.7	45.9	23.3	65.6
M3	177.8	70.3	100.0	13.7	34.4	100.0
M4						
M5						
M6						
M7						
M8						
M9						
M10						
	253.0					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.38

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 236

SAMPLE : KIPP #6

SIZE RANGE: 0.6x0.2 mm

TEST CONDITIONS

1) MAGNET CCT: 100 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
   B: 17
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 6.6 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	258.5			27.8		
M0						
M1	33.2	12.9	12.9	75.5	35.0	35.0
M2	44.4	17.2	30.1	43.8	27.1	62.1
M3	180.1	69.9	100.0	15.1	37.9	100.0
M4						
M5						
M6						
M7						
M8						
M9						
M10						
	257.7					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 239

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

TEST NO: 237

JOB NO : 2044.

SAMPLE : LINGAN #3

TESTING STAGE: 3

SIZE RANGE: 0.6X0.2mm

DATE :

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
   B: 16
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 3.0 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA						
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH				
FEED	249.5			26.1						
M0										
M1	55.1	22.2	22.2	84.6	71.8	71.8				
M2	18.5	7.4	29.6	54.7	15.5	87.3				
M3	175.0	70.4	100.0	4.7	12.7	100.0				
M4										
M5										
M6										
M7										
M8										
M9										
M10										
	248.6									

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 240

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044

TESTING STAGE: 3

DATE :

TEST NO: 237

SAMPLE : LINGAN #3

SIZE RANGE: 0.6x0.2mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
   B: 16
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 30 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE	DIST.			%DIST	CUM
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH
FEED	249.5					
M0						
M1	55.1	22.2	22.2	84.6	72.8	72.8
M2	18.5	7.4	24.6	54.7	15.7	88.5
M3	175.0	70.4	100.0	4.2	11.5	100.0
M4						
M5						
M6						
M7						
M8						
M9						
M10						
	248.6					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.41

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 238

SAMPLE : LINGAN #3

SIZE RANGE: 0.6x0.2mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
   B: 17
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 4.3 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	254.6			26.0		
M0						
M1	46.6	18.4	18.4	85.1	60.2	60.2
M2	27.4	10.8	29.2	61.1	25.4	85.6
M3	179.8	70.8	100.0	5.3	14.4	100.0
M4						
M5						
M6						
M7						
M8						
M9						
M10						
	253.8					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 242

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044

TESTING STAGE: 3

DATE :

TEST NO: 239

SAMPLE : LINGAN #3

SIZE RANGE: 0.6×0.2 mm

TEST CONDITIONS

1) MAGNET CCT: 100 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
B: 19
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 6.5 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	249.7			25.7		
M10						
M1	48.3	19.3	19.3	83.6	62.7	62.7
M12	34.0	13.6	32.9	45.4	24.0	24.0
M3	167.5	67.1	100.0	5.1	13.3	13.3
M4						
M5						
M6						
M7						
M8						
M9						
M10						
	249.8					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 243

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 240

SAMPLE : LINGAN #2

SIZE RANGE: 1.4X0.6 mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
B: 16
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 2.3 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	259.2					
M10						
M11	27.8	10.8	10.8	76.1	55.9	55.9
M12	10.8	4.2	15.0	59.2	16.9	72.8
M3	11.1	4.3	19.3	31.3	9.1	81.9
M4	209.0	80.7	100.0	3.3	18.1	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	258.7					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 244

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044

TESTING STAGE: 3

DATE :

TEST NO: 241

SAMPLE : LINGAN #2

SIZE RANGE: 1.4x0.6 mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
B: 16
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 3.6 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE	DIST.			%DIST	CUM
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH
FEED	250.5			14.1		
M0						
M1	26.4	10.6	10.6	77.5	58.1	58.1
M2	11.2	4.5	15.1	54.1	17.2	75.3
M3	14.0	5.6	20.7	22.7	9.0	84.3
M4	198.6	79.3	100.0	2.8	15.7	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	250.2					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 245

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

TEST NO: 242

JOB NO : 2044.

SAMPLE : LINGAN #2

TESTING STAGE: 3

SIZE RANGE: 1.4 x 0.6 mm

DATE :

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
   B: 17
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 5.7 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	253.4			14.5		
M0						
M1	29.0	11.5	11.5	77.8	61.9	61.9
M2	11.0	4.4	15.9	46.8	14.2	76.1
M3	17.2	6.8	22.7	15.5	7.3	83.4
M4	195.0	77.3	100.0	3.1	16.6	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	252.2					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.46

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 243

SAMPLE : KIPP #5

SIZE RANGE: 2.0x0.6

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
   B: 16
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 2.2 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	248.0			26.0		
M0						
M1	38.3	15.6	15.6	71.7	43.1	43.1
M2	20.6	8.4	24.0	52.2	16.9	60.0
M3	28.3	11.5	35.5	28.7	12.7	72.7
M4	159.0	64.5	100.0	11.0	27.3	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	246.2					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 247

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 244

SAMPLE : KIPP #5

SIZE RANGE: 2.0×0.6 mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
B: 16
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 3.6 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE	DIST.			%DIST	CUM
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH
FEED	255.5			13.6		
M0						
M1	40.4	15.8	15.8	71.6	43 5	43.5
M2	23.2	9.1	24.9	49.3	17 3	60.8
M3	36.4	14.3	39.2	24 6	13.5	74.3
M4	155.0	60.8	100.0	11.0	25.7	100.0
M5						
M6						
M7						
M8						
M9						
M10						

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.48

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 245

SAMPLE : KIPP #5

SIZE RANGE: 2.0×0.6mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
B:
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 5.8 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE Wt. (g)	DIST. %	DIST. %CUM	%ASH	%DIST ASH	CUM %ASH
FEED	251.4					
M0						
M1	46.3	18.5	18.5	72.5	51.4	51.4
M2	23.2	9.3	27.8	39.8	14.2	65.6
M3	46.0	18.3	46.3	19.2	13.5	79.1
M4	135.2	53.9	100.0	10.1	20.9	100.0
M5						
M6						
M7						
M8						
M9						
M10						
	250.7					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.49

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

JOB NO : 2044.

TESTING STAGE: 3

DATE :

TEST NO: 246

SAMPLE : LINGAN #1

SIZE RANGE: 2.8X1.4mm

TEST CONDITIONS

1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
B: 18
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 30 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE	DIST.			%DIST	CUM
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH
FEED	249.0			29.1		
M0						
M1	62.4	25.1	25.1	82.5	71.2	71.2
M2	26.2	10.6	35.7	47.5	17.3	88.5
M3	159.7	64.3	100.0	5.2	11.5	100.0
M4						
M5						
M6						
M7						
M8						
M9						
M10						
	248.3					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.51

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

TEST NO: 247

JOB NO : 2044.

SAMPLE : LINGAN #1

TESTING STAGE: 3

SIZE RANGE: 2.8X1.4mm

DATE :

TEST CONDITIONS

1) MAGNET CCT: 100 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
   B: 19
   C:
   D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 3.6 TPHPM

	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE	DIST.			%DIST	CUM
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH
FEED	259.5			31.2		
M0						
M1	77.0	29.7	29.7	82.8	78.9	78.9
M2	29.0	11.2	40.9	35.0	12.6	91.5
M3	153.0	59.1	100.0	4.5	8.5	100.0
M4						
M5						
M6						
M7						
M8						
M9						
M10						
	259.0					

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MAGNETIC SEPARATION TEST FACILITY

TABLE: 2.52

NOTES: INCLINED FALL, MULTI-SPLIT

INCLINED FALL MULTI-SPLIT SEPARATION

CUSTOMER: CANMET

TEST NO: 248

JOB NO : 2044.

SAMPLE : LINGAN #1

TESTING STAGE: 3

SIZE RANGE: 2.8x1.4mm

DATE :

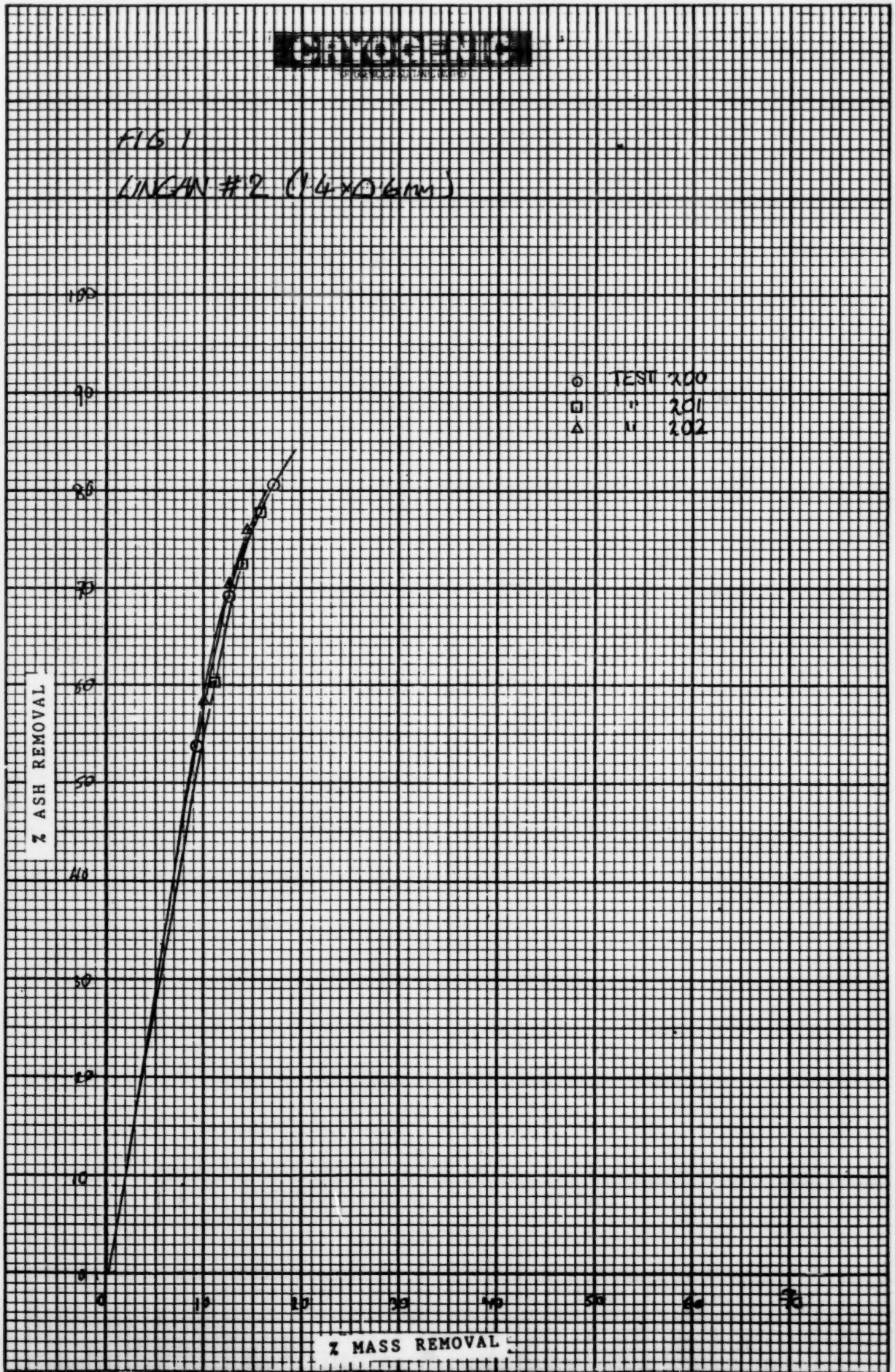
TEST CONDITIONS

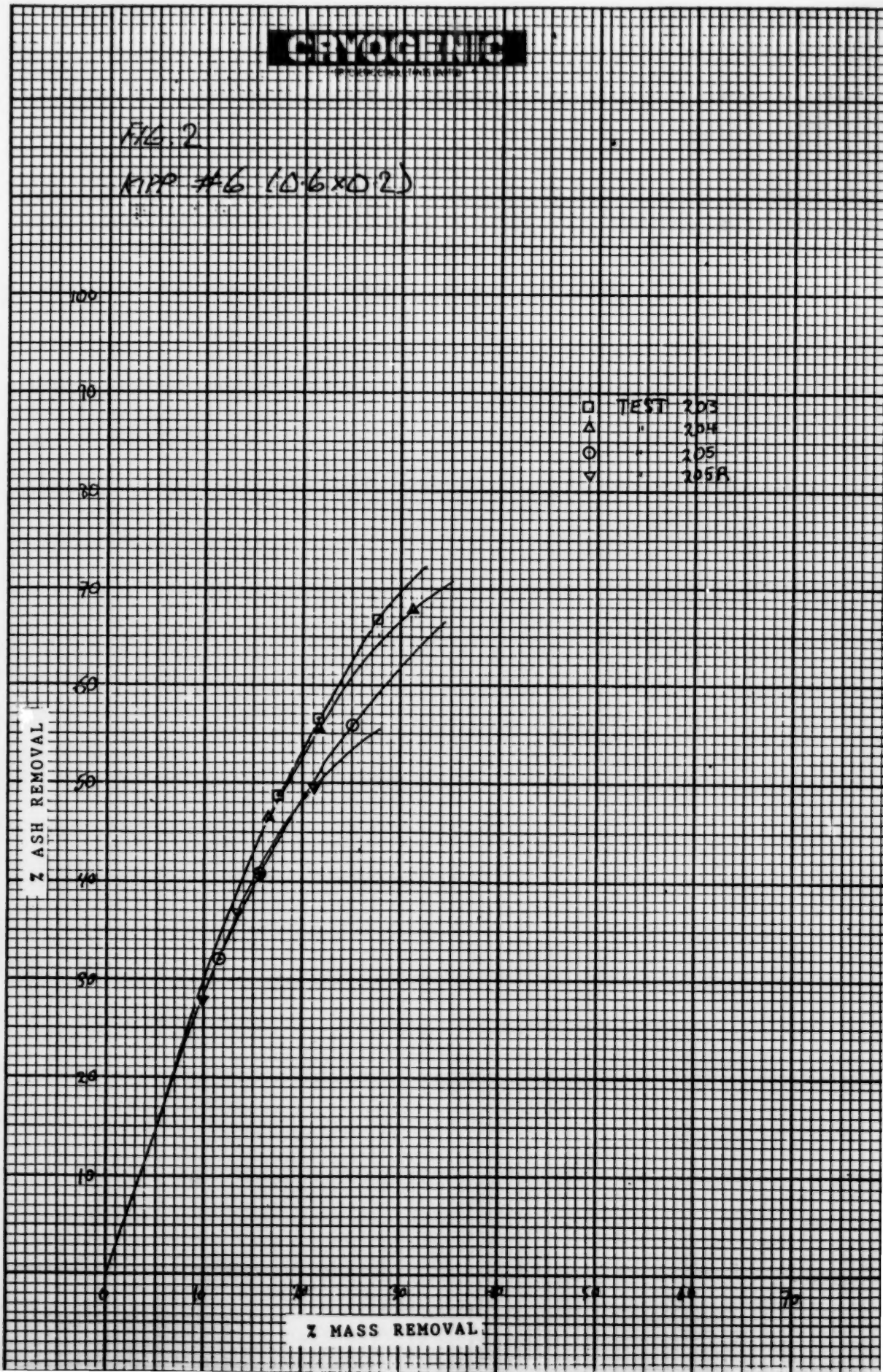
1) MAGNET CCT: 65 AMPS:
2) INCLINE ANGLE: 22°
3) DIMENSIONS (mm) A: 35
B: 20
C:
D:
4) CHANNEL SETTING:
5) PASS TIME: SEC:
6) FEED RATE: 7.0 TPHPM

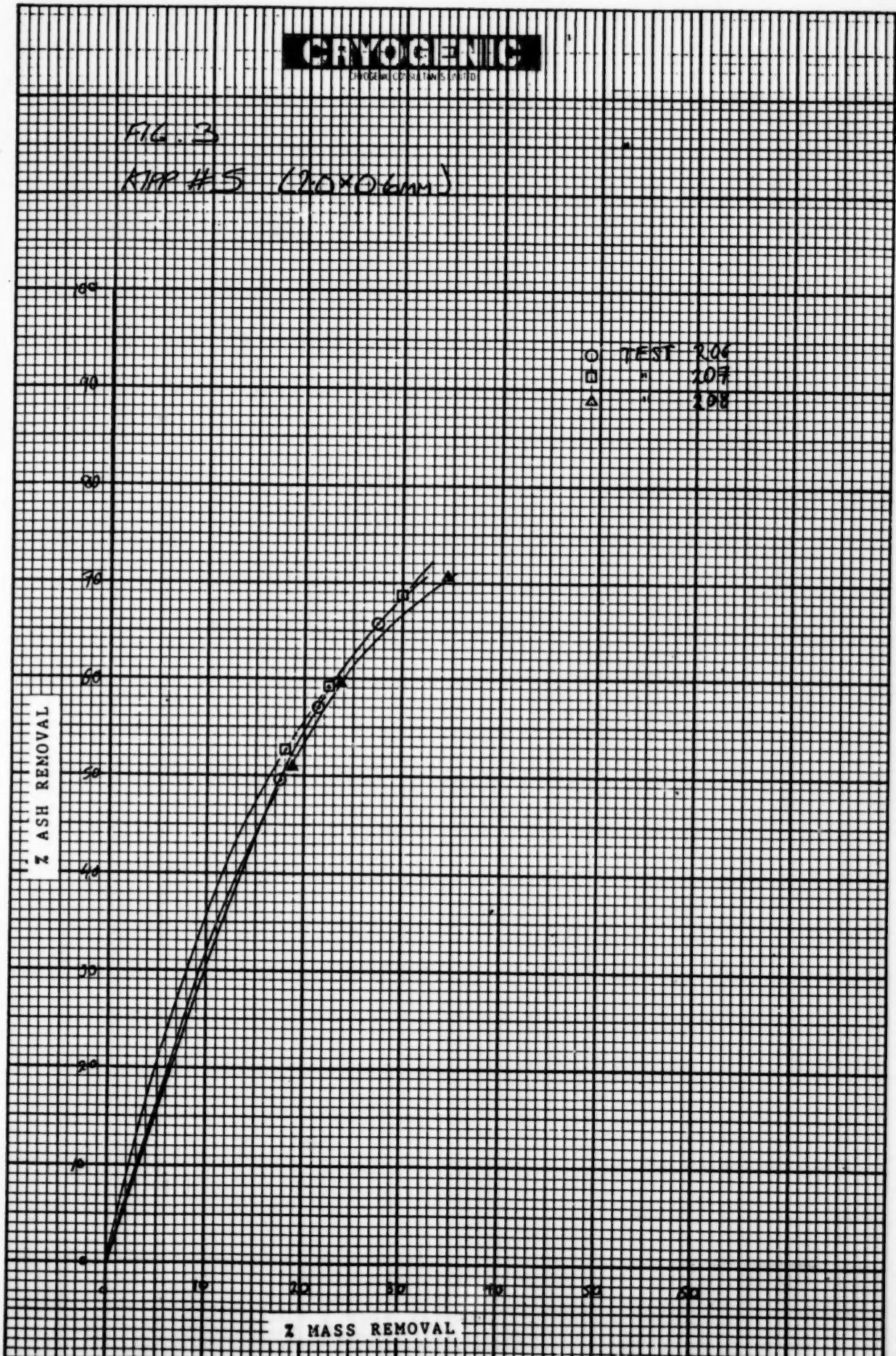
	SEPARATED MASS DATA			ANALYSIS DATA		
	SAMPLE	DIST.			%DIST	CUM
	Wt. (g)	%	%CUM	%ASH	ASH	%ASH
FEED	246.2			30.3		
M0						
M1	69.2	28.6	28.6	82.8	78.1	78.1
M2	26.1	10.8	39.4	37.4	13.3	91.4
M3	146.4	60.6	100.0	4.3	8.6	100.0
M4						
M5						
M6						
M7						
M8						
M9						
M10						
	241.7					

FIG 1

LINCAN #2 (1.4×0.6mm)




CRYOGENIC
FIG. 2
KIPP #6 (0.6 x 0.2)
□ TEST 203
△ " 204
⊙ " 205
▽ " 205R
Z ASH REMOVAL
Z MASS REMOVAL
100
90
80
70
60
50
40
30
20
10
0
10
20
30
40
50
60
70


CRYOGENIC
CRYOGENIC CONSULTANTS LIMITED
FIG. 3
KIRR #5 (2.0×0.6mm)
TEST 206
207
208
% ASH REMOVAL
% MASS REMOVAL

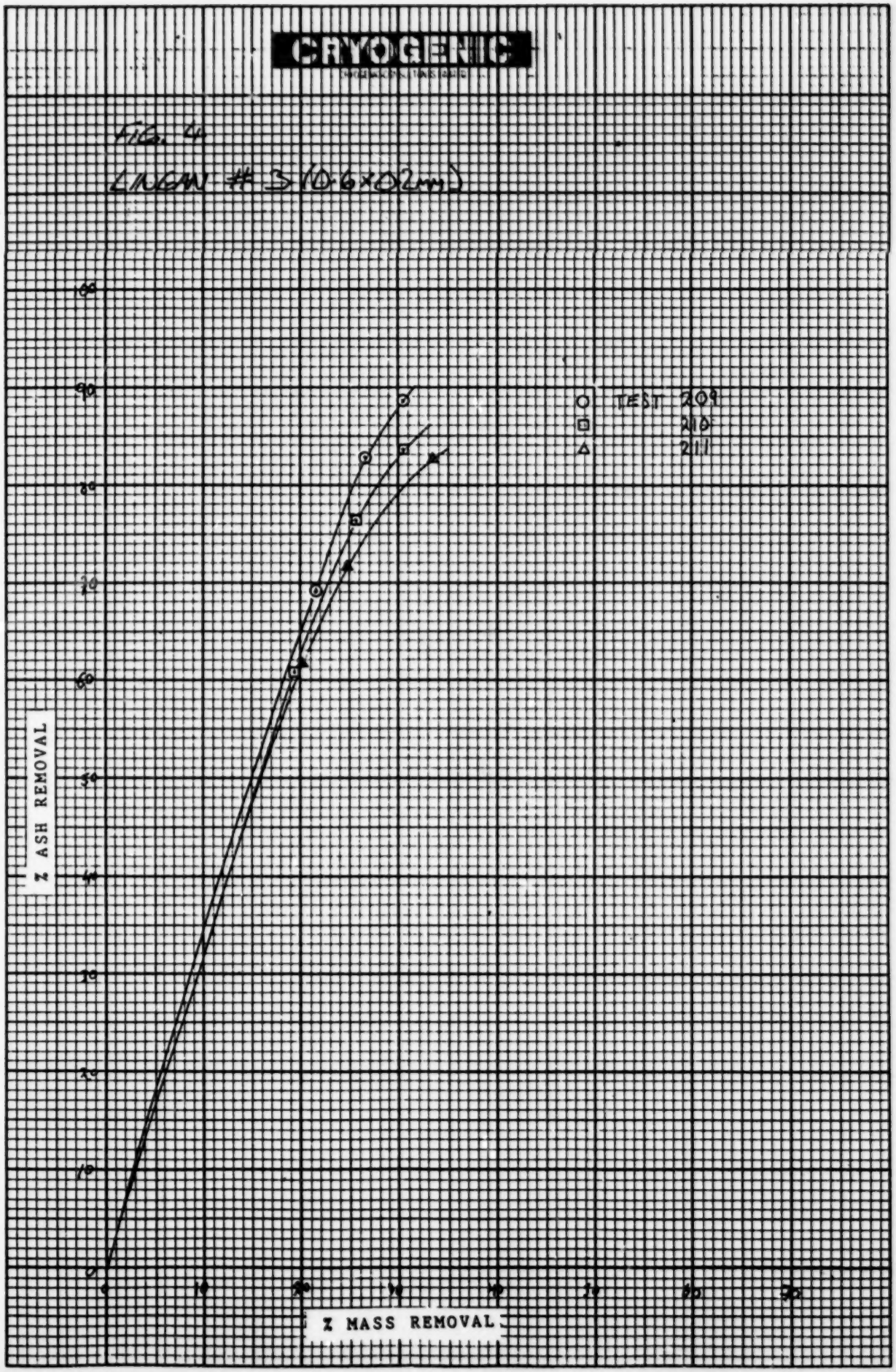

CRYOGENIC
Fig. 4
LNG#3 (0.6×0.2mm)
TEST 209
210
211
% ASH REMOVAL
% MASS REMOVAL

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FIG. 5

PRNCA #2 (0.6x0.7 mm)

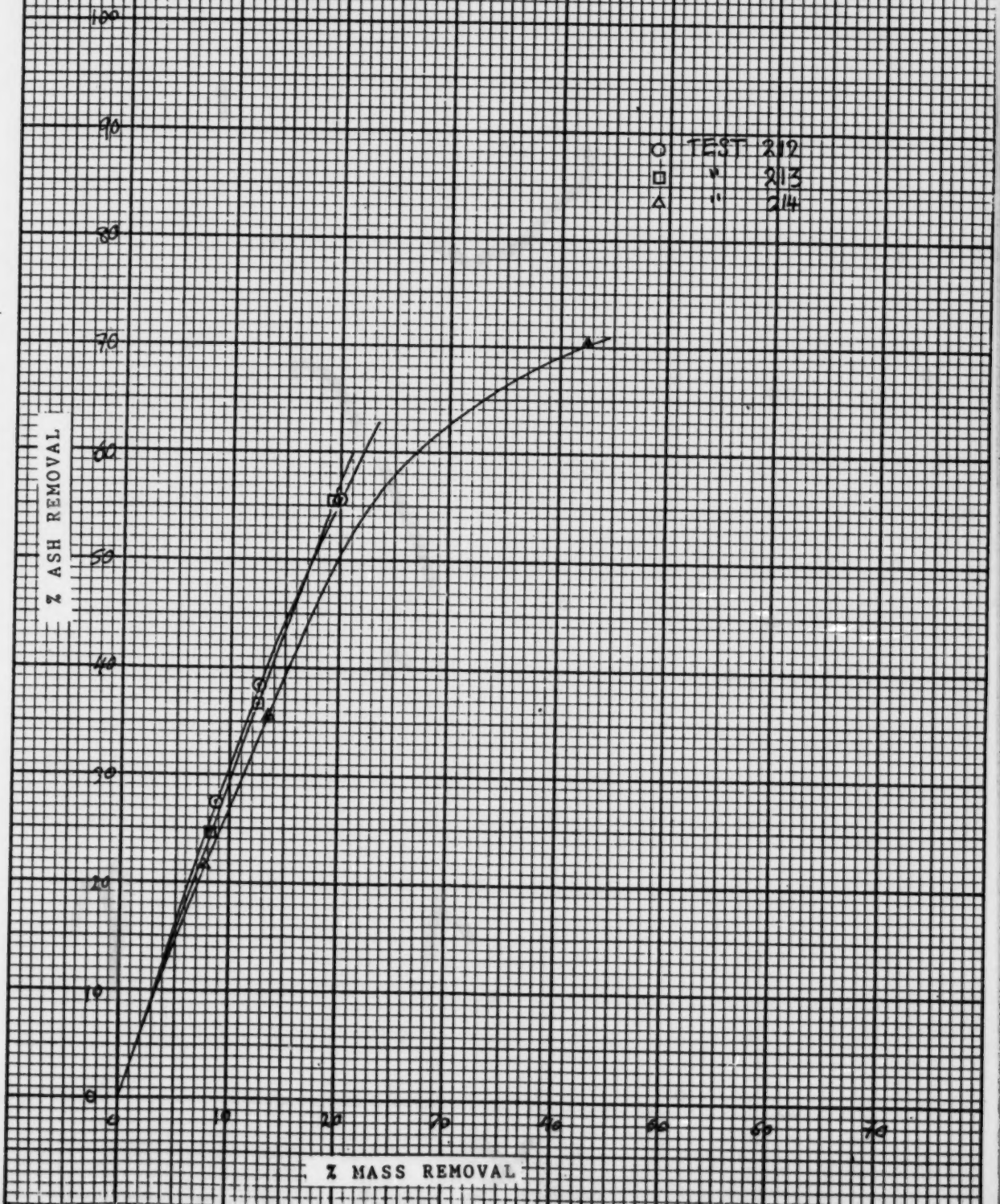

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FIG. 6a

LNCAN #1 (2.8 x 1.6 mm)

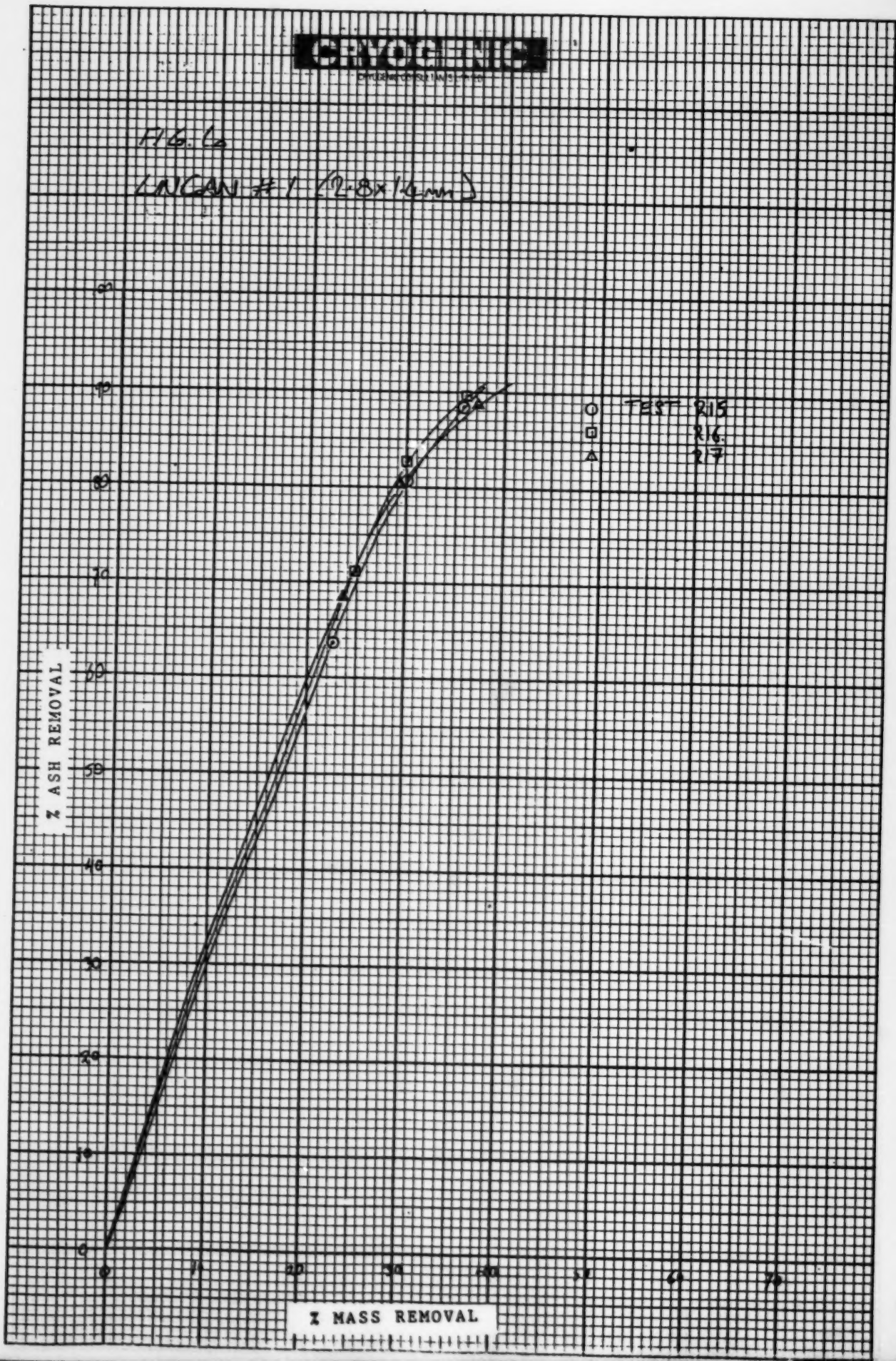

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FIG. 7

4 MGAN #4 (0.2 x 0.1 mm)

□ TEST 218
△ 219

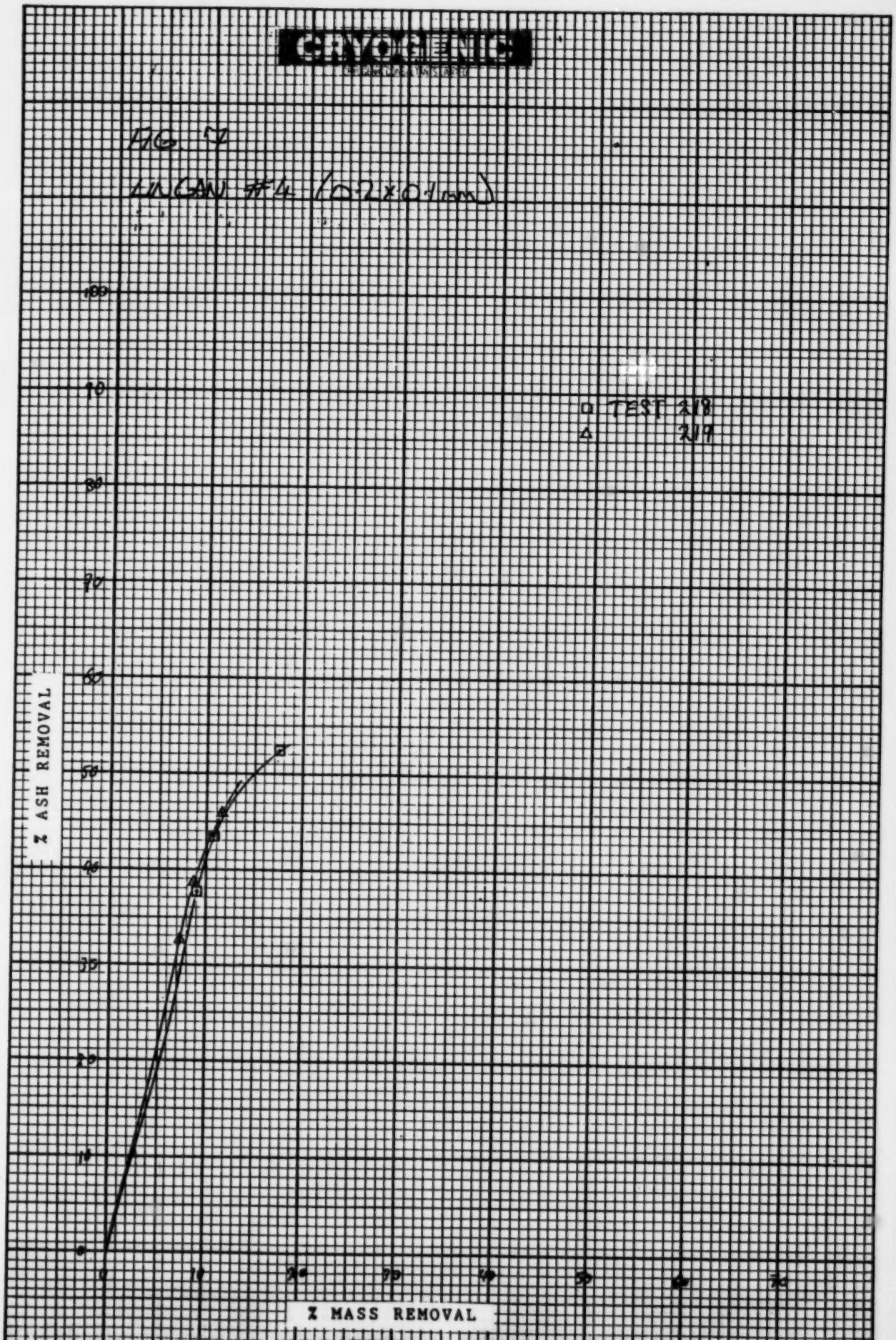

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FIG. B

KMR AT 7 (0.2×0.1 mm)

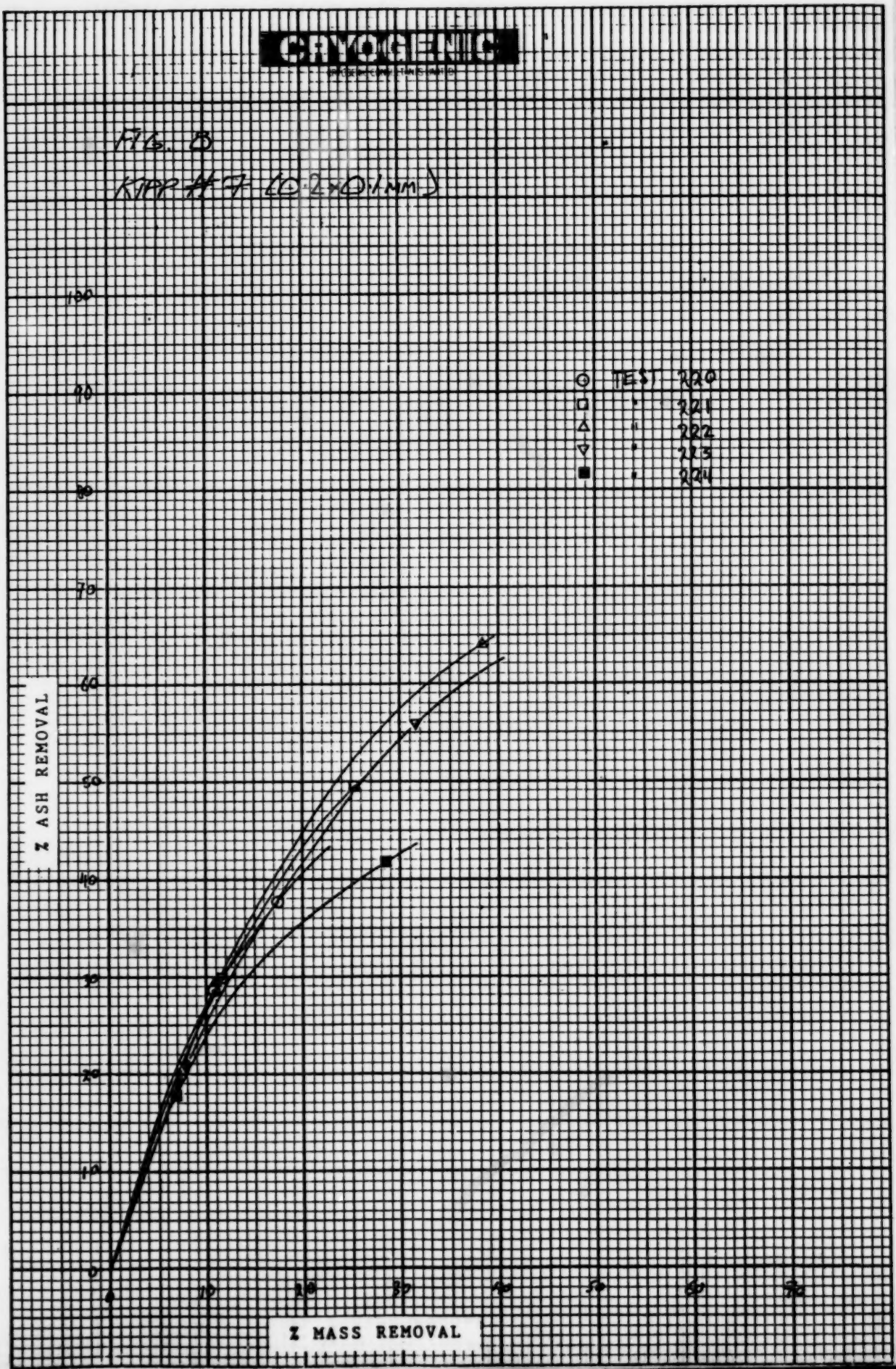

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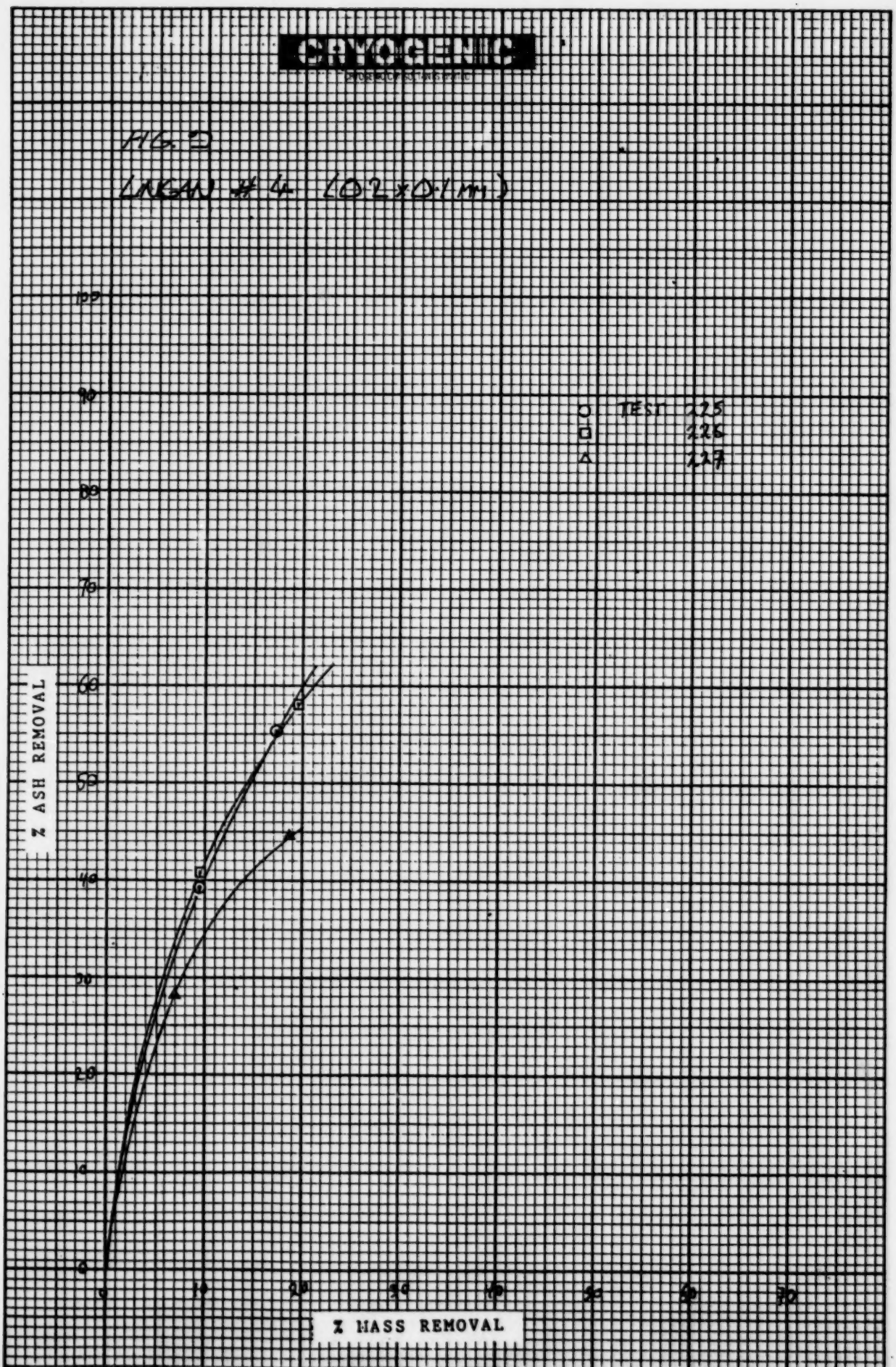
FIG. 2

LIGNITE # 4 (102 x 0.1 mm)



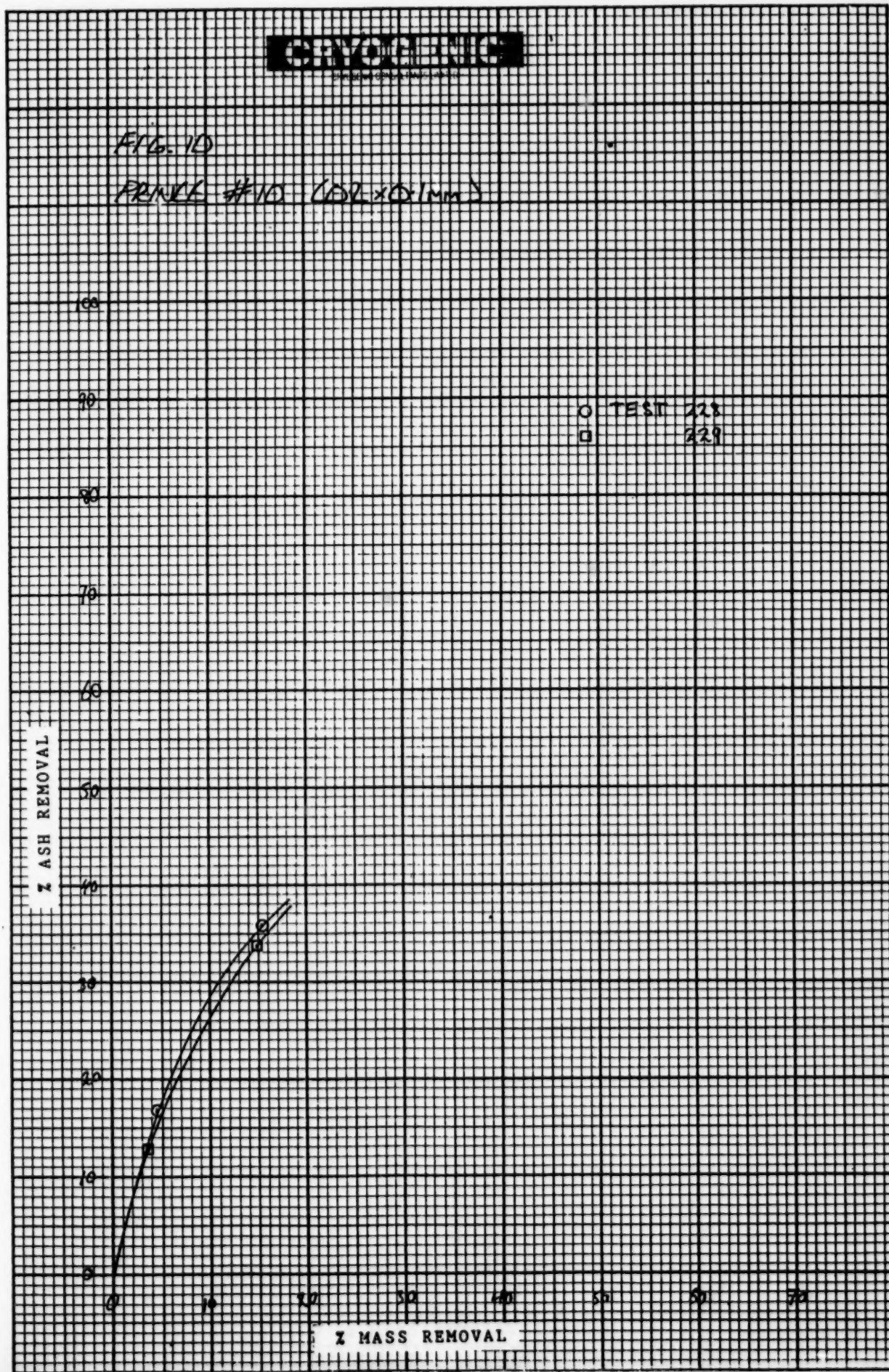


FIG. 10
PRINCE #10 (CDL x 0.1mm)
TEST 223
229
% ASH REMOVAL
% MASS REMOVAL
0
10
20
30
40
50
60
70
80
90
100

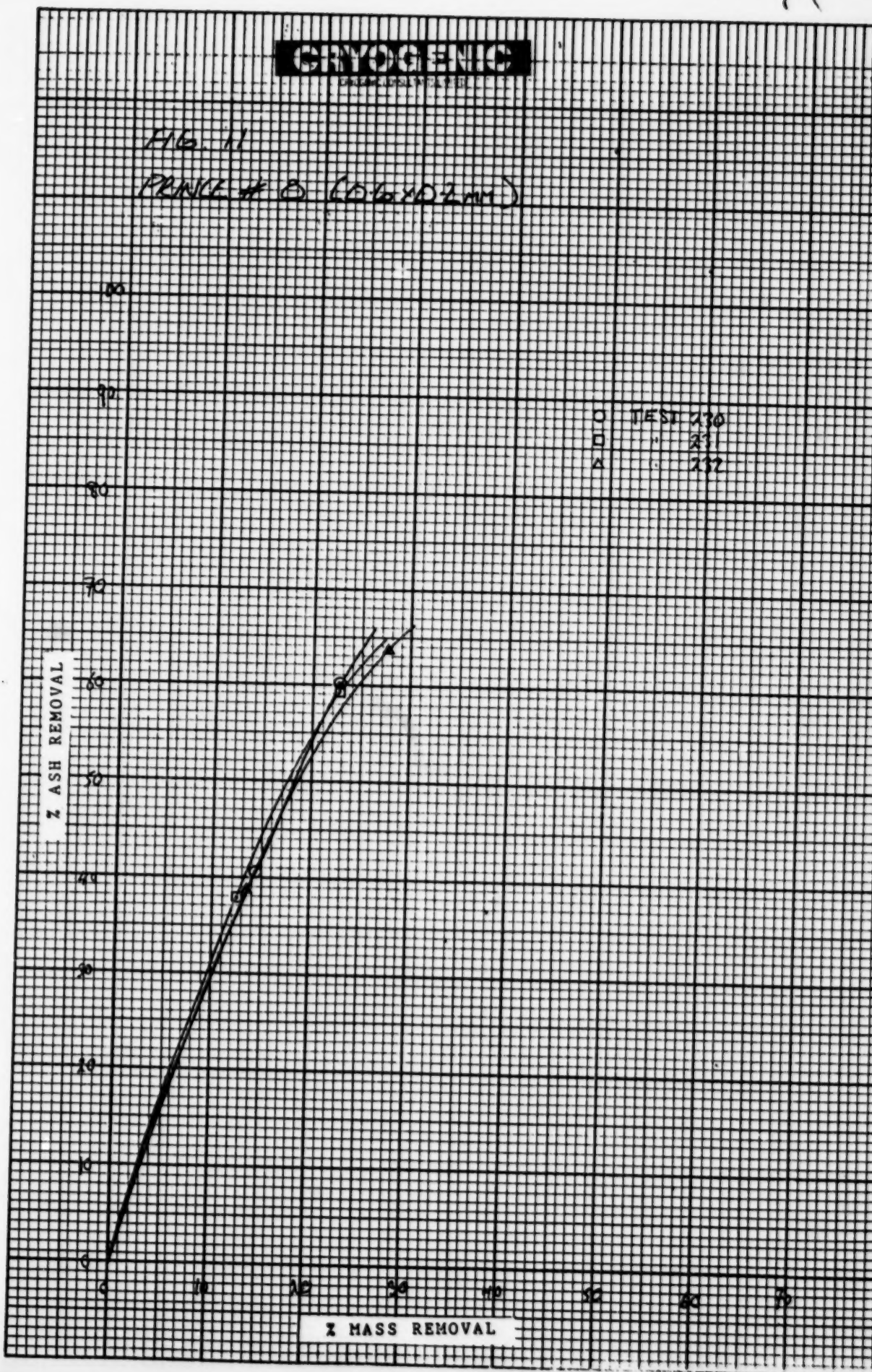

CRYOGENIC
FIG. 11
PENCE # 8 (0.6x0.2mm)
TEST 230
231
232
% ASH REMOVAL
% MASS REMOVAL
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70

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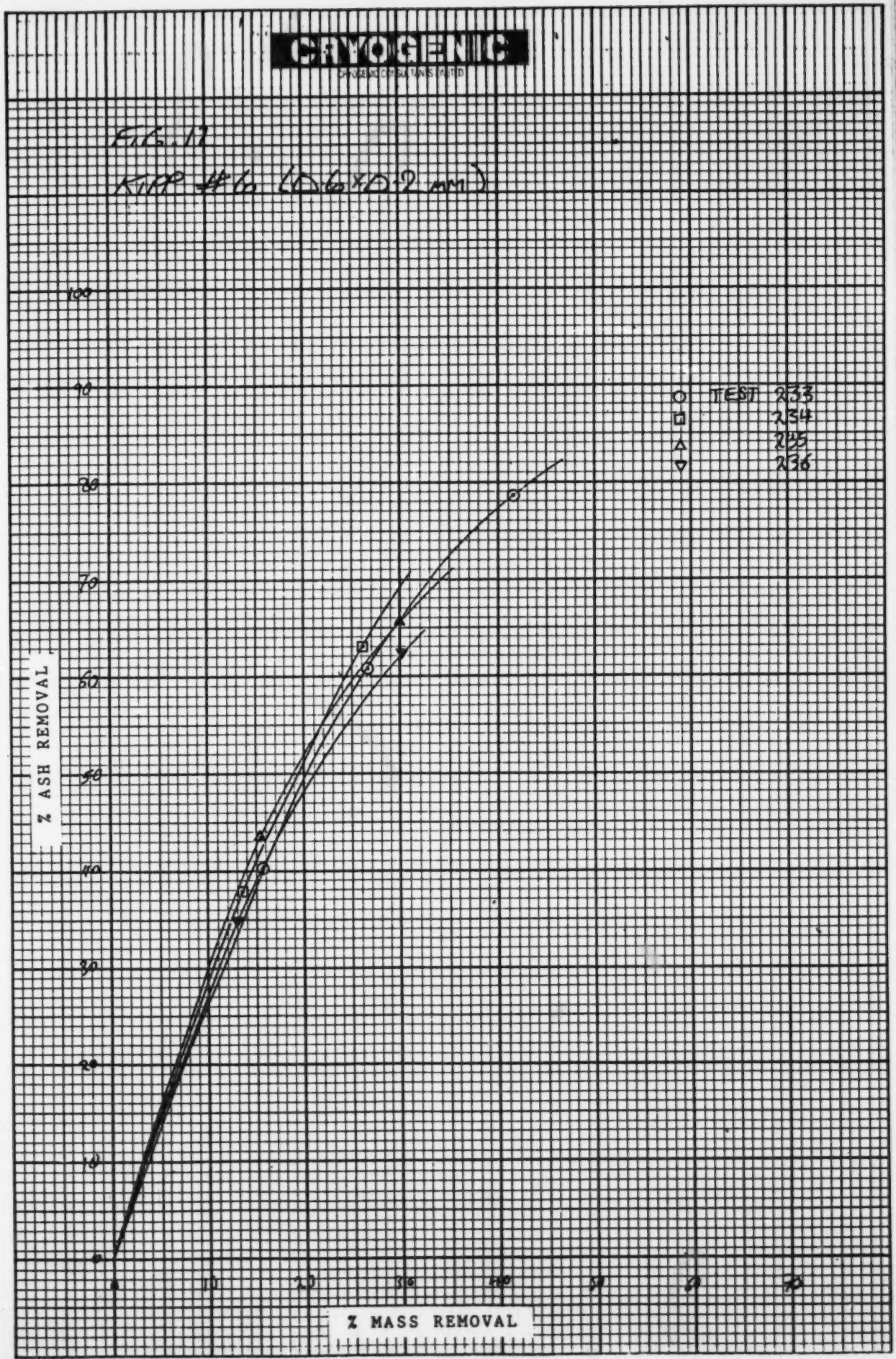
FIG. 17

KIMP #6 (0.6×0.12 mm)



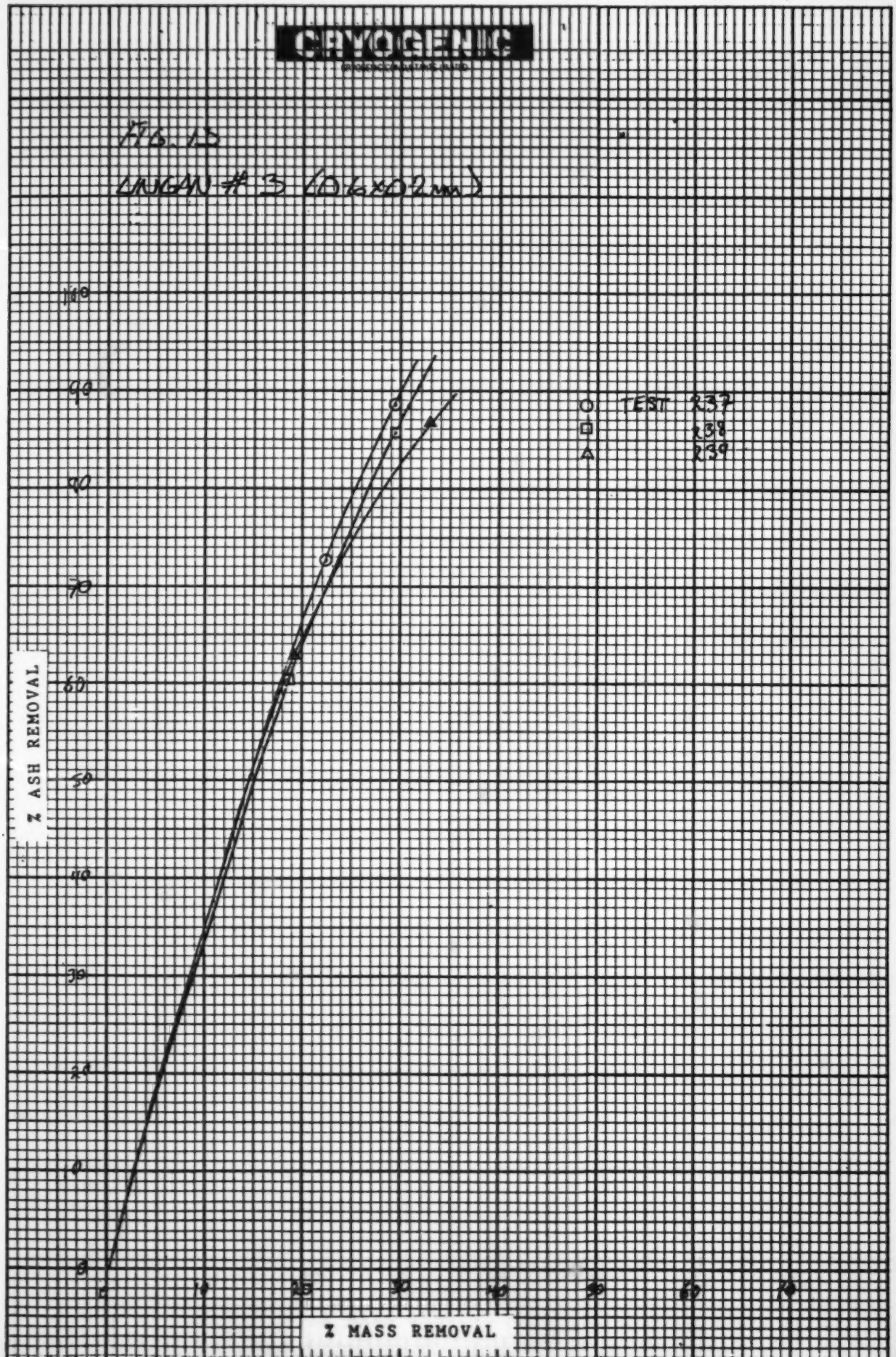

CRYOGENIC
FIG. 15
UNION #3 (0.6×0.2 mm)
TEST
237
238
239
% ASH REMOVAL
% MASS REMOVAL

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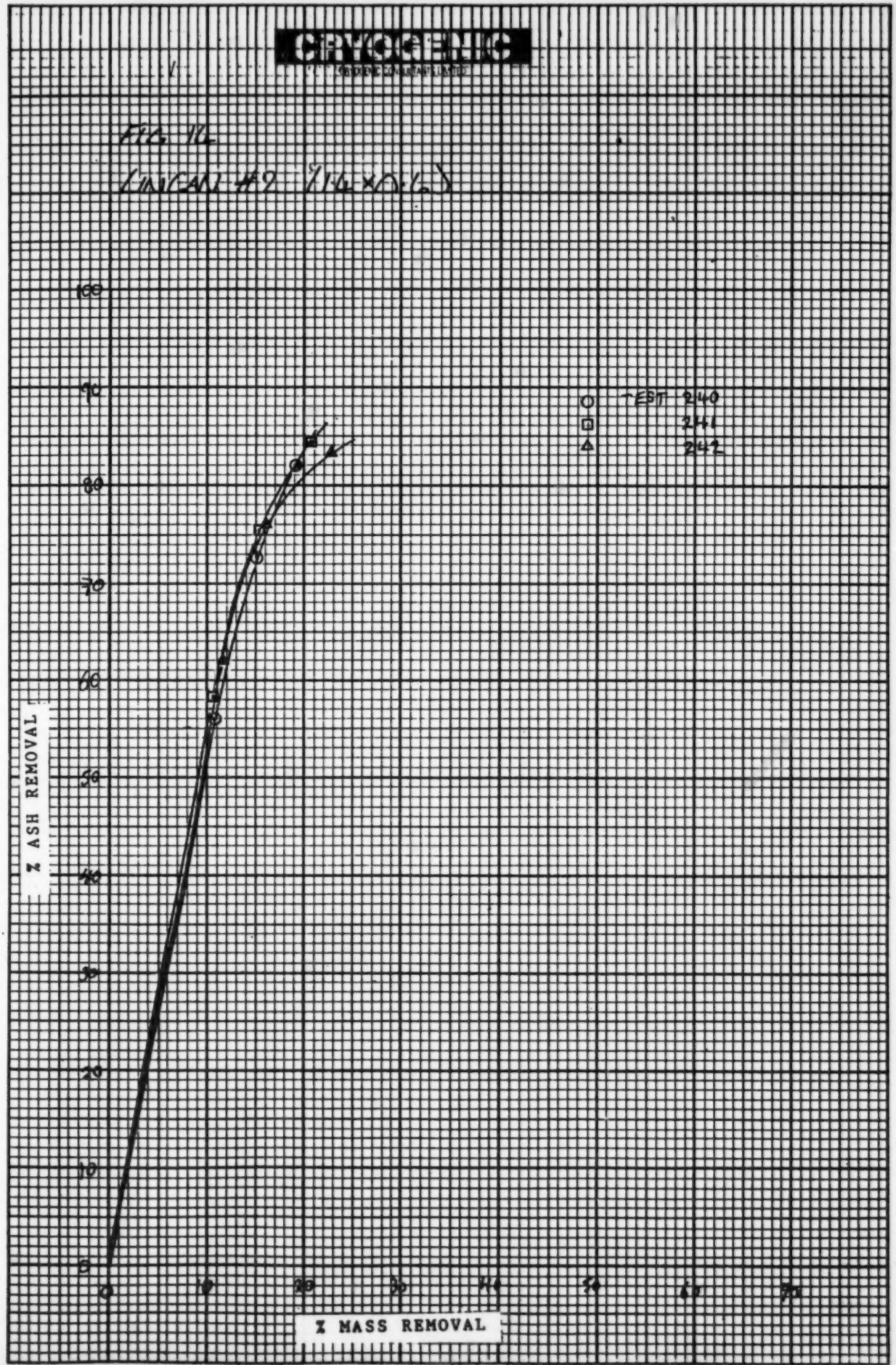
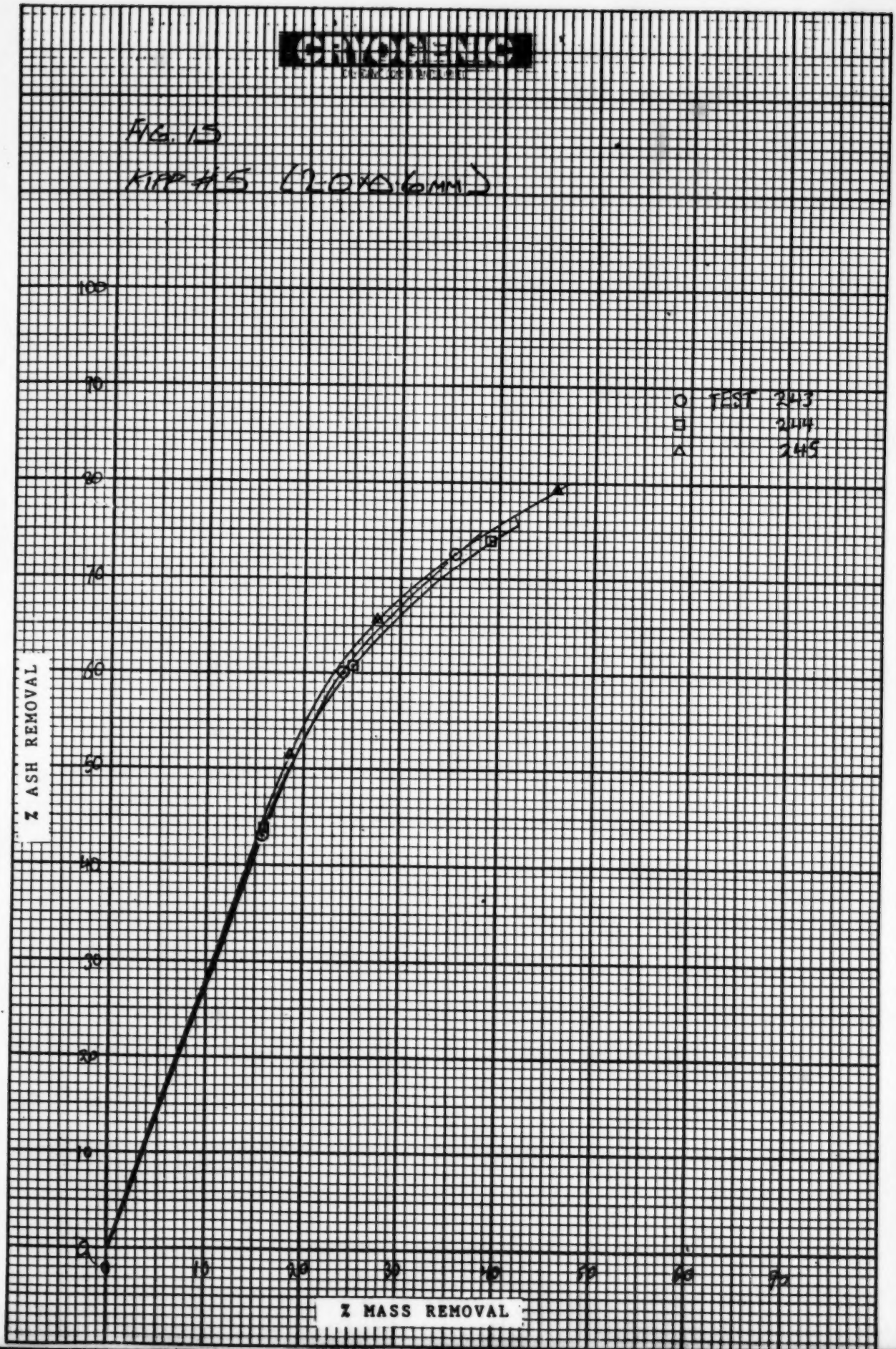
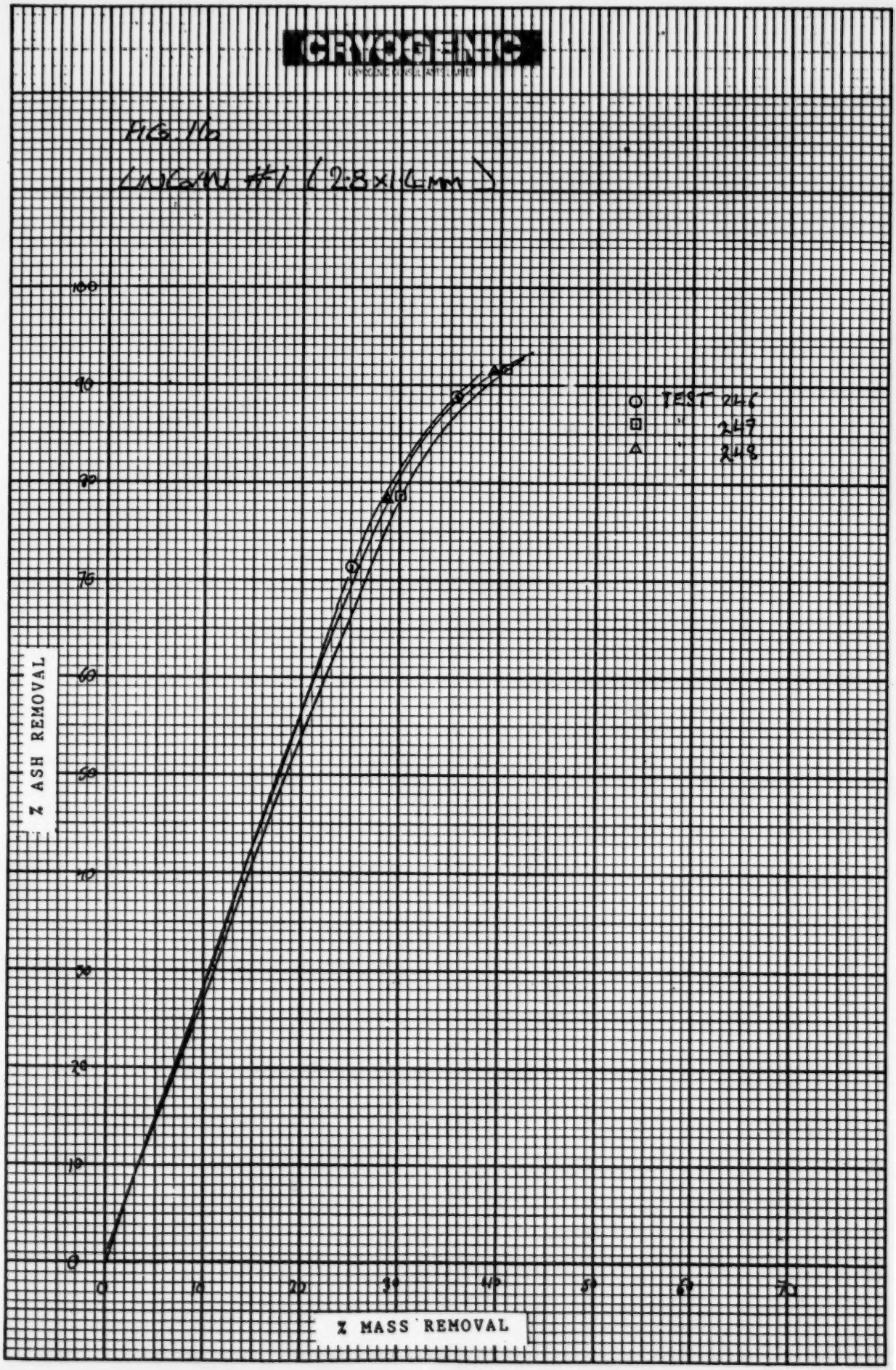
FIG 14

LINCAN #9 (14×0.4)




CRYOGENIC
FIG. 15
KIP #5 (2.0×0.6mm)
O TEST 243
□ 244
△ 245
Z ASH REMOVAL
Z MASS REMOVAL


CRYOGENIC
FIG. IIa
UNICARB #1 (2.8×1.6mm)
TEST 246
247
248
% ASH REMOVAL
% MASS REMOVAL
0
10
20
30
40
50
60
70
80
90
100

APPENDIX I

CRYOGENIC

ANNOUNCING AN IMPORTANT NEW DEVELOPMENT IN OPEN GRADIENT SUPERCONDUCTING MAGNETIC SEPARATION

A significant break-through in dry high intensity magnetic separation is announced by CRYOGENIC in the form of the new Inclined Fall Open Gradient process. By combining the practical simplicity of a newly developed open gradient technique with the exceptional magnetic force provided by available superconducting magnets substantial improvements can be made in the economics and quality of existing magnetic separation processes. Also a wider range of industrial applications, including novel process routes and the treatment of very weakly magnetic materials is now envisaged.

The considerable power of the process is readily demonstrated by the ability to separate extremely weakly magnetic materials with susceptibilities approaching 10^{-7} emu/g from non-magnetics. The process can also be highly selective being capable of effecting a clean separation between weakly magnetic materials of differing magnetic susceptibilities.

The classical process associated with dry mineral beneficiation on open gradient superconducting magnet separators has been the falling curtain technique illustrated in Figure (1). In 1982 CRYOGENIC, in collaboration with The Phosphate Development Corporation, made a substantial improvement to this method using a ramp assisted free fall process shown in Figure (2). In the only independent published study comparing superconducting magnet separators with conventional dry high intensity separators, including IMR and the strongest rare earth permanent magnet drum separators, the ramp assisted technique employed with a CRYOGENIC open gradient superconducting magnet produced improved grade and recovery values at significantly higher processing capacities. This in turn resulted in the first order for a commercial open gradient superconducting magnet separator.

Despite the great success associated with the ramp assisted free fall technique it has been recognised that the geometry of the process did not allow the full power of the superconducting magnet to be utilised.

The most apparent limitation in both of the above processes is that the separation takes place away from the magnet face where the forces are noticeably below their highest level. A glance at Figure (4) which shows the magnetic force profile for a linear superconducting magnet clearly demonstrates the point. Another drawback of the earlier processes is that the mags must not stick to the magnet wall as this would cause clogging of the separator. To prevent this from happening the mineral stream is allowed to fall from a certain height above the separation region so that the mags only undergo deflection and not capture. This also has the effect of degrading the effectiveness of the available magnetic force, especially as the release height is dictated by the strongest magnetic constituents. Finally, when processing at large capacities collisions between particles and coherent streaming reduce the quality of the separation.

The new separation process reduces these problems significantly by taking advantage of the more practical linear superconducting magnet design and by introducing a totally different ore handling technique. The basic process details are shown in Figure (3). Material is fed into the high magnetic field region using a vibrating table. On leaving the table the particles will fall along a specific trajectory dependent on their magnetic susceptibility. Non-magnetics will simply fall vertically downwards whereas the magnetics fall at an angle away from the vertical or in the case of the more strongly magnetic actually adhere to, and be carried away by the belt passing over the magnet face. The advantages of this process are summarised as follows :-

1 Being an open gradient process there is no need for secondary poles or return poles hence there are no restrictions to material flow. There are no problems, therefore, with blockage due to over-size or fibrous material.

2 The process is continuous with the belt providing a steady cleaning action.

3 The separator will tolerate a very high percentage of magnetics and still have a high throughput. In one example an ore with over 80% magnetics gave highly promising results with capacities in excess of 10 tonnes per hour per metre length of magnet.

4 The feed point may be arranged so that all particles pass through the highest magnetic force region allowing separation of extremely weakly magnetic materials.

5 In comparison with the earlier processes, the effects of collisions or coherent streaming are reduced because a greater portion of the magnetic field volume can be utilised and by allowing the particles to enter the separation zone at almost zero velocity they remain in the magnetic field for a longer time (longer residence time). These two features increase the probability of diverting a magnetic particle into the mags stream as well as allowing a non-magnetic scattered or drawn into the mags stream to fall out into the tails. We note that with the earlier processes, once a non-magnetic particle entered the mags stream there was no chance of it ever escaping into the tails.

6 The magnetic forces achieved with CRYOGENIC's superconducting magnets are long range as indicated in Figure (4). This allows the separation to be highly selective at high processing rates. It is now possible to separate mixtures of magnetic materials with differing magnetic susceptibilities in a single pass.

7 It is readily seen that the cleanest separation is best achieved when the magnetic force and the competing force act in opposite directions. It follows, therefore, that the inclination of the linear magnet is an extremely useful variable, being increased for separating strongly magnetic particles and decreased for the weakest. The 'window' for materials which can be effectively separated has, therefore, been increased in both directions.

8 Orientation of the magnet at an incline can provide physically much larger separations between the magnetics and tails. Whereas, in the earlier processes the final separation distance between the mags and tails was typically two or three centimetres, it is now possible to effect separation of twenty centimetres or more. Splitter positioning is now less critical with a resultant improvement in the quality of the separation and process control is much simplified.

There can be little doubt that the Inclined Fall separation process offers substantial improvements over the already highly effective ramp assisted free fall technique. Despite the recency of this development highly ecnouraging results have already been obtained. For example, in the search for the ultimate power of the process it has been shown that Potassium Permanganate with a magnetic susceptibility of 1.75×10^{-7} emu/g could be separated from non magnetic quartz yielding nearly 80% grade magnetic product with over 90% recovery in a single pass. This performance is well beyond the limits of the most powerful conventional open gradient or IMR separators even exceeding the capabilities of the laboratory Frantz Isodynamic separator. Alternatively, the selectivity of the process has been clearly demonstrated by its ability to separate a mixture comprising of nickel sulphate (1.6×10^{-5} emu/g) copper sulphate (6×10^{-6} emu/g) and glass sand (non-magnetic) into nearly perfect individual fractions also in a single pass.

The examples quoted above have used artificial minerals in order to provide quantitative estimates of the separation power. Natural minerals were not used as it is known that they exhibit a wide variation of magnetic properties and it is always possible to exaggerate the capabilities of a separator by choosing extreme examples to imply typical performance. Separation tests are now also being commenced for potential commercial end users on natural ores and preliminary results have already reflected the superiority of this new process.

CRYOGENIC is now adapting and expanding its magnetic separation testing facility to include the Inclined Fall open gradient separation process as a standard. Details of our test programmes and normal handling procedures are available from :-

Magnetic Separation Test Facility,
Cryogenic Consultants Limited
Metrostore Building
231 The Vale
Acton
London W3 7QS
England

Telephone No : (01) 743 6049
Telex No : 935675

AAS/EMW
14.01.1987

FIG.1 PLAIN FALLING CURTAIN PROCESS

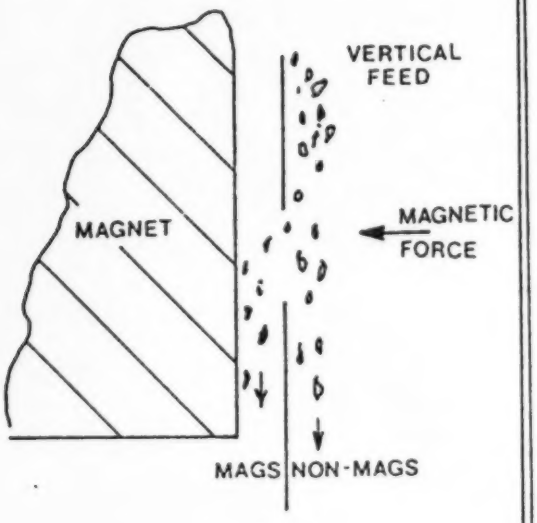


FIG.2 FALLING CURTAIN WITH DEFLECTOR RAMP

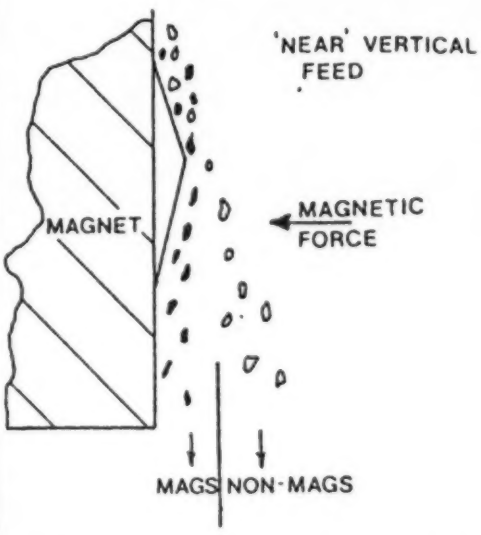


FIG.3 INCLINED FALL SEPARATION PROCESS

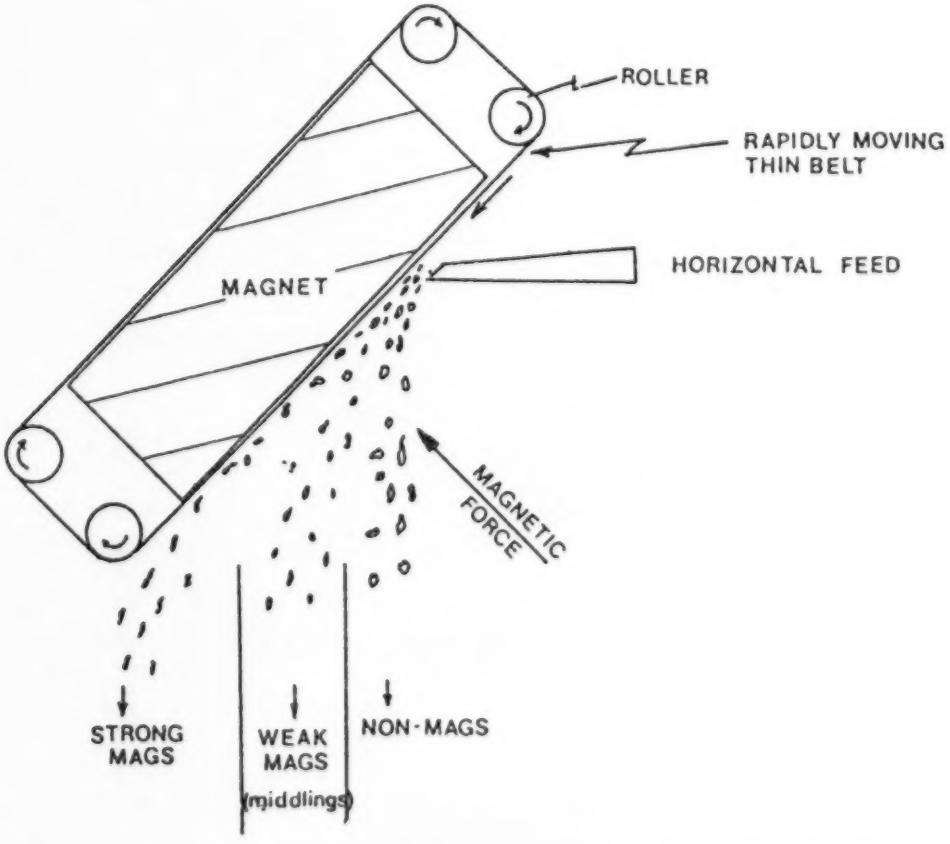
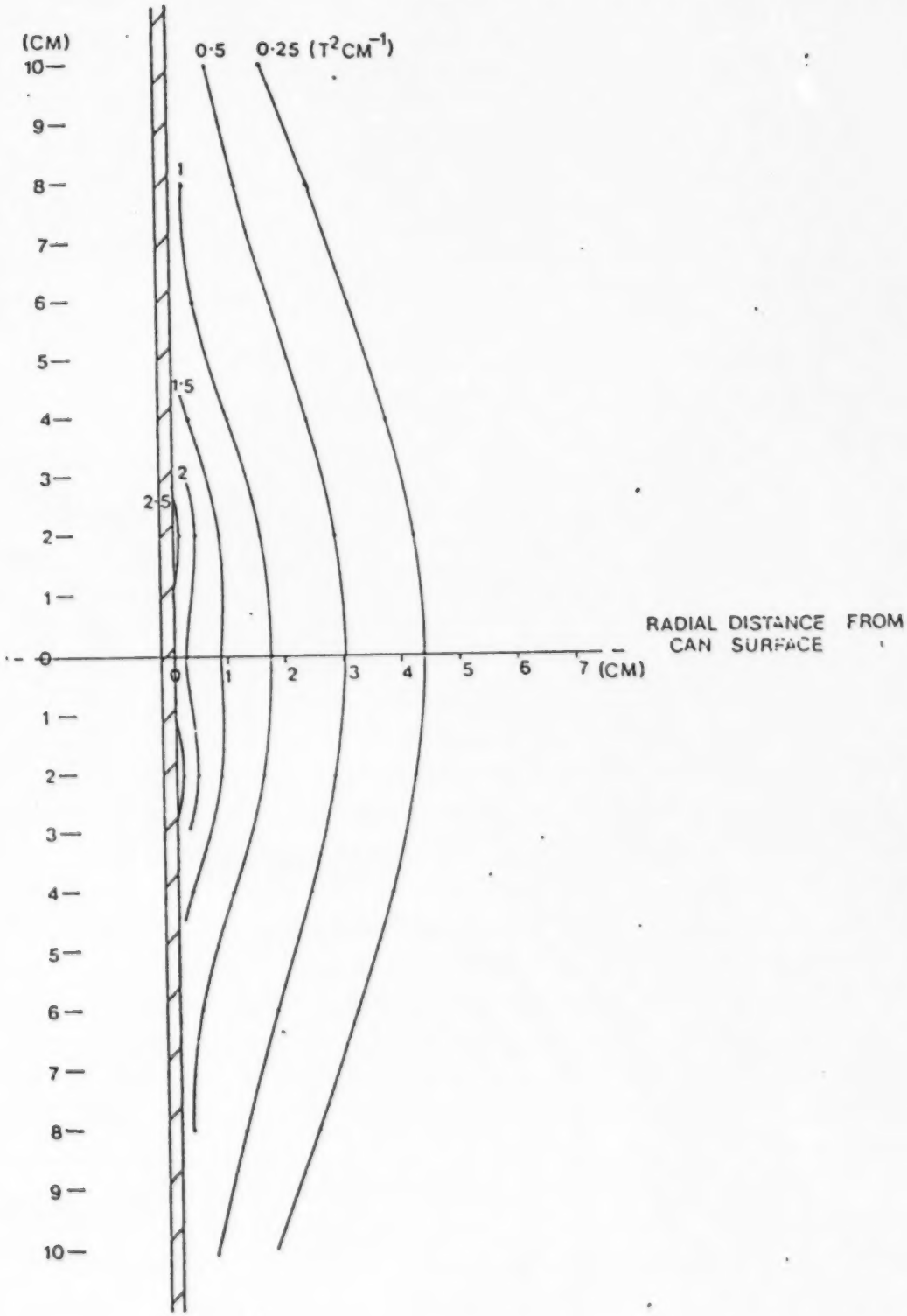


FIG.4 CRYOSEP LHC - FORCE PROFILE

(Magnet Current = 65 Amps)